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THESIS

AN INTRODUCTION TO COMMAND AND CONTROL

by

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Command and control activities have long been recognized as a vital part of military operations. From shouted battlefield commands to today's information-age warfare, it is those who have mastered the techniques and applications of command and control who have most often prevailed. As critical as it is to our success, it is a topic that is controversial, often poorly understood, and subject to wildly different interpretations.

This thesis examines the command and control process, consisting of people, information, and structure, and the interaction between the function of command and the systems that facilitate the process. It is intended to serve as a roadmap for the study of this topic from a foundational standpoint by first exploring the doctrinal definitions used throughout DoD and developing a sense of what command and control is, and equally important, what it is not. It then focuses on the components of the process and the dynamic relationships that exist between them. Finally, it considers our future, as outlined by such visions as JV2020 and Network-Centric Warfare, in hopes of identifying and understanding those things that will challenge us in developing an effective process.

Command and control influences every facet of warfare. In preparing for a future that calls for increased use of technology and systems, it is critical that we understand the process in order to remain an effective force.

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AN INTRODUCTION TO COMMAND AND CONTROL

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Command and control activities have long been recognized as a vital part of military operations. From shouted battlefield commands to today's information-age warfare, it is those who have mastered the techniques and applications of command and control who have most often prevailed. As critical as it is to our success, it is a topic that is controversial, often poorly understood, and subject to wildly different interpretations.

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I. INTRODUCTION

A. BACKGROUND

> One of the least controversial things that can be said about command and control is that it is controversial, poorly understood, and subject to wildly different interpretations. (Moll, 1978)

Command and control (C^2) activities have long been recognized as a vital part of military campaigns. From Alexander the Great's shouted battlefield commands to recent "information age engagements," those who have mastered the techniques and applications of command and control have most often prevailed in combat. Current and future Department of Defense doctrine highlights the importance of command and control, often describing it as vital or critical to our success, and it is regularly identified as the single biggest challenge in today's operating environment. As important as it is to our success, it is not always a topic easily understood and it is often avoided completely. The infusion of technology into our processes, the increasing demand for information, changing operational environments, and fluid organizational structures all contribute to the often over-looked, misunderstood concept of command and control.

No single activity in war is more important than command and control. Command by itself will not drive home a single attack against an enemy force. It will not destroy a single enemy target. Yet none of these essential warfighting activities, or any others, would be possible

without effective command and control. (MCDP 6, p. 35) Given the importance of the topic, it is imperative for warfighters to understand both the art and the science of command and control as part of a well-rounded professional military education. Few military institutions attempt to educate students on this topic, and those that do, are often geared more towards the systems that facilitate command and control rather than the process critical to our success. The Naval Postgraduate School, offering a course in Introduction to Command, Control, Communications, Computers and Intelligence (C^4I), provides a means to satisfy this requirement. A recommendation to the Command, Control, and Communications academic group, responsible for the course, to adjust the focus of the course to the function and process of command and control provided the genesis for this thesis.

B. PURPOSE

The purpose of this thesis is the development of a document that addresses the central themes of command and control. During the conduct of research for this project, course material in the form of readings, slide presentations, and case studies was compiled for use in a classroom environment. This material is on CD-ROM and is available through the Command, Control, and Communications (C3) Academic Group. This document is intended to provide the reader with an overview of topics and themes that run throughout the course material. Relating those theories to how we conduct business today and how we envision operations of the future helps identify challenges we must

consider as we move towards a network-centric environment. Equally important in understanding what C^2 is about, is gaining an appreciation for what it is not. This document will serve as the road map for such an undertaking. As indicated, the appendices consisting of classroom material will be provided in CD-ROM format.

C. SCOPE

This thesis is directed towards mid-grade officers with operational experience at the tactical level. It will focus primarily on developing an understanding of command and control theories and concepts and the integration of systems that support them. Doctrine, organizations, roles, and war-fighting philosophies of each service within the Department of Defense will also be discussed. Because the topic is broad in scope, in-depth analysis of each module will not be possible; rather an understanding of the relevant issues relating to command and control will be the goal. The intent is to expose the readers to the challenges, provide resources for further education, and prepare someone for future assignments at either the tactical or operational level.

Command and control systems and architectures although not covered separately, are discussed throughout the thesis with special emphasis placed on the challenges associated with them. Course material is provided on these subjects and will require updating on a regular basis to keep pace with the rapid changes occurring in the military. A more detailed study of the plethora of C^2 systems is of value, but falls beyond the scope of this thesis. Based upon an

individual's interpretation of command and control, one could build an endless list of topics that are relevant to its study. Documents used span the range from joint and service specific doctrine to individual articles with special emphasis paid to those dealing with tactical-level command and control theories and concepts. Leadership, although not specifically addressed, is organic to how one builds effective command and control, which is covered in detail.

D. METHODOLOGY OF RESEARCH

As the information revolution has taken hold over the last thirty years, the topic of command and control has been extensively written about. There also exists a much larger set of writings that explore the technical issues related to command and control. Endless amounts have been written about particular systems, methods of communication, types of software, employment tactics, and measures of effectiveness. (Thrasher, p.2) Identifying relevant topics that capture the fundamental issues from the imposing amount of information available seemed a daunting task. Topic selection was completed after input from numerous sources including DoD schools, active and retired military officers, and faculty from NPS. These are discussed below.

1. Department of Defense Schools

The majority of entry and intermediate level schools throughout DoD cover C^2 as part of a larger course identified in a number of ways including C^3, C^4I, C^4I^2, and so on. Most entry-level and intermediate programs devote

only a few hours to the basics before moving into more technical material, which is focused on training. The top-level schools (for O-5s and O-6s) that focus on command and control exclusively as part of their curriculum do so in seminar format relying on the writings of Snyder, Van Creveld, Clausewitz, and the like. Although these works were helpful, they did not provide a comprehensive list as many of the areas covered were beyond the scope of an introductory course. A query of course outlines and academic summary sheets was most helpful in identifying resource material from which to build an outline. Concepts covered in the command and control modules and the top-level seminars provided boundaries to work within.

2. Doctrinal Publications, C2 Oriented Books and Articles

A readings-based approach to studying an area of interest is not a new idea. Selecting a "best of" reading list is by nature a subjective undertaking. Selection of books and articles was done so based on the following criteria:

- Does the source explain one or more key command and control concepts?
- Are the explanations geared toward the average military reader?
- Is the source available to the larger military community?

Material meeting the above criteria, and DoD doctrinal publications, were used to identify potential topics relevant to the study of command and control. The focus was further defined after conducting interviews.

3. Interviews with Senior Leaders, Professors, and Students

Discussion with active and retired flag officers was invaluable in helping identify the critical elements of command and control. Their focus tended to be on the "art" of the process. Recognizing strengths and weaknesses of the people under their charge and the importance of experience were the central themes of their message. They also articulated a guarded concern regarding micro-management that they perceived could occur as a result of an increased reliance on technology.

Professors in the C3 and Special Operations academic groups not only provided guidance on class structure and the mechanics of course design, they also provided keen insight to the challenges faced by today's decision makers and the role of the organization in building an effective command and control process. They also assisted in case study selection to be used as a mechanism to augment classroom instruction with real-world challenges.

Interviews were conducted with students to obtain an appreciation of what they felt were the relevant issues with regards to command and control. Students interviewed were mid-grade officer (O-3 and O-4s) coming from all branches of the service and included those who had previously taken a course related to this area and those who had not. Experience and command opportunities varied immensely, but none had worked extensively at the operational level. The majority of those interviewed approached the topic from a systems standpoint and wanted a

better appreciation for the process and challenges we face in the future as we move towards a more networked organization.

Based on these inputs, a recommended thesis outline was sent to, and approved by, the C3 academic group, which served as the framework for this research and course material development.

E. THESIS ORGANIZATION

Chapters II through VII address the fundamental topics identified with command and control. Each chapter describes the salient points based on the reference material intermixed with personal interpretation based on experience and training. Although the material is intended to be comprehensive in nature, my understanding of the material and opinions offered are in large part due to my specific branch of service and experiences. Going to the source and pursuing the readings in their totality will certainly provide clarification if needed and other perspectives. In addition to the bibliography, appendix (1) contains the most relevant references used in this study. They are intended for class reading assignments. Copyright authorization for their use is included. Appendix (2) contains the in-class presentation material, in the form of power-point slides. These are intended to serve as a trigger mechanism for discussions on the concepts found in the readings.

Chapter II explores C^2 terms and definitions as outlined in service and joint doctrine. Some clarity is injected by identifying the relationship between command,

command and control, and the systems involved. The C^2 process emerges as the focal point of discussion, and the role of the components involved are addressed.

Chapter III examines the activities within the C^2 domain through the use of conceptual models. It examines characteristics and dynamics of the process and focuses on the importance of balance between information gathering and decision-making. The operating environment is addressed, and an exploration of the evolution of C^2 provides valuable insight into how technology has influenced the process.

Chapter IV describes organizational theories and how they are related to effectiveness. Hierarchical and network properties are discussed and their utilization in the military bureaucracy is diagnosed. Formulation of C^2 organizations, that allows us to realize the visions articulated in doctrine such as Joint Vision (JV) 2020, and the challenges associated with them, are discussed.

Chapter V concentrates on decision making from a commander's perspective. Analytical and intuitive processes each have applicability, depending on the situation at hand. The dynamics between organizational, informational, and operational decisions must be understood to ensure effectiveness as commanders strive to do the right thing faster and more accurately than the enemy.

Chapter VI focuses on the components of effective command and control. Regardless of the system being used, it is the people in the process that are the key to success, and the commander is the heart of the system. The role the commander takes, his relationship with staff and subordinates, and the flexibility he allows his subordinate

commanders largely determines the effectiveness of their command and control system.

Chapter VII is dedicated to the challenges associated with command and control. The validity of information is a concern as commanders search for the right information to make the right decisions. Sole reliance on technology to obtain, process, and deliver information leaves us vulnerable if the technology fails or becomes compromised. The most reliable and redundant systems provide little value if a significant investment is not made in people, training, and interoperability. A top-down approach with regards to systems development is discussed, noting that it will be required if we are to meet emerging requirements with limited resources. Competing for those limited resources by evaluating C^2 systems as a force multiplier is difficult to accomplish. Determining what data to analyze and how to collect it will often determine how well C^2 systems compete against weapon systems. Both quantitative and qualitative analysis techniques to accomplish this are discussed.

A summary of the information discussed throughout the thesis and some recommendations are offered in Chapter VIII. It is important to understand the challenges of command control, both the ones we face today an the emerging ones of the future, before we can begin to offer recommendations for dealing with them.

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II. COMMAND AND CONTROL PRINCIPLES

A. TERMS AND DEFINITIONS

The term "command and control", or some derivation thereof, has become a common part of today's military vocabulary. Most in our profession recognize the term, which unfortunately, is the limit of our shared understanding. The breadth of C^2 allows the term to mean whatever the user whishes it to mean. Some may focus on the technology while others tend to concentrate on the human aspect of the topic. Contributing to the problem is the proliferation of confusing terms, used interchangeably, relating to this area. "Command," "command and control," "command, control, and communications," and their seemingly never-ending extrapolations only add to the confusion.

The confusion does not obscure the basic nature of command and control, and any meaningful study of the topic requires common terms of reference. These common terms of reference will provide the framework for shared concepts, based on a set of logical and coherent definitions, for the various aspects of command and control. (Thrasher, p. 4) Joint and service doctrine are the source documents upon which the foundational "framing" of the topic will be built, and an obvious place to start is with the Department of Defense (DoD) definition for command and control found in Joint Publication 1-02:

> The exercise of authority and direction by a properly designated commander over assigned forces in the accomplishment of the mission. Command and control functions are performed through an arrangement of personnel, equipment, communications, facilities, and procedures which

> are employed by a commander in planning, directing, coordinating, and controlling forces and operations in the accomplishment of the mission. (JP 1-02, p.80)

Service definitions use this as a guideline, with minor modifications to address unique mission or capabilities. The Army defines C^2 as:

> The exercise of authority and direction by a properly designated commander over assigned and attached forces in the accomplishment of the mission. (FM 6-0 Draft, p.1-1)

The Navy definition is:

> Command and control enables the naval commander to understand the situation in his battlespace, select a course of action, issue intent and orders, monitor the execution of operations, and evaluate the results. It is the primary tool he uses to cope with the disorder and uncertainty of warfare. (NDP 6, p.6)

The Air Force expands upon the definition by describing it as:

> C^2 includes both the process by which the commander decides what action is to be taken and the system which monitors the implementation of the system. Specifically, C^2 includes the battlespace management process of planning, directing, coordinating, and controlling forces and operations. C^2 involves the integration of the systems of procedures, organizational structures, personnel, equipment, facilities, information, and communications designed to enable a commander to exercise command and control across the range of military operations. (AFDD1, p.160)

Finally, the Marine Corps describes *command and control* as:

> The means by which a commander recognizes what needs to be done and sees to it that appropriate actions are taken. (MCDP 6, p.37)

Buried within these definitions are the components of command and control. Prominent figures in the study of C^2 such as Snyder, Coakley, and Van Creveld, and select military doctrine, help in defining the key components of the command and control process. In order to understand the process it is necessary to understand the entities inherent to the process and their relationships. The first critical component is about a commander exercising authority, or what is commonly called the command function. Control activities, occurring throughout and in conjunction with the command function comprise the C^2 process. The C^2 systems consist of the equipment, facilities and procedures that facilitate the function and process of command and control.

1. The Command Function

Central to understanding of C^2 is the idea of "command" as a military function that has to be exercised more or less continuously. (Van Creveld, p.8) Command is the authority vested in individuals in order to clearly delineate responsibility and foster unity of effort through the direction, coordination, and supervision of military forces. Ultimately, it is the commander who is responsible for what has to be done and ensuring that decisions made are properly executed. (Snyder, p.44) Considered mostly an art form, command improves with experience, training and self-development, but can only be exercised by the commander. The art of command lies in the exercise of

authority to fulfill responsibilities through decision-making and leadership. A commander is not identified as successful due to specific techniques or procedures he employs, but rather by his ability to accomplish the mission in the most efficient manner possible. Regardless of the doctrine cited or expert quoted, command is the fundamental warfighting function that all other aspects of C^2 must support.

2. Control Activities

Control activities would not exist without command, yet they serve the commander, allowing him to regulate forces and operating systems. Activities include collecting, processing, displaying, storing, and disseminating information for use by the staff during planning, preparing for, executing, and assessing operations. Communication conveys the information from one person or place to another and is multi-directional in nature providing for a feedback mechanism to the command function. Relationships and procedures established throughout the organization enable control activities. (FM 6-0 p. 1-2) From this, it is clear that control involves the whole organization, especially those who are part of the C^2 system and increases in complexity with each higher echelon of command. People other than the commander can perform control activities, and in fact, this is one of the primary duties of the staff, but the commander must actively participate in either exercising or supervising control for it to be effective.

Control is mostly science, but some art. Objective data, analytic processes, and scientific methods and theories used in planning, preparing for, and executing operations address the scientific nature of control. Understanding and incorporating the notion that control activities will influence information obtained on friendly and enemy forces that will be used by the commander in performing the command function addresses the inherent art of effective control.

3. The C^2 Process

The procedures employed by a commander in executing the C^2 function (command) are called the C^2 process. The DoD definitions describe the process in which the command function and control activities are interwoven. The C^2 process includes specific approaches a commander uses to learn, decide, organize, communicate and monitor. These specifics can be as varied as the commanders influencing them, and therefore are not consistent between echelons of command, but all involve people, information, and structure. A platoon commander will employ a different process than a Joint Task Force (JTF) commander. These variances are a function of technology, location, organization, responsibility, and any number of variables that a commander may face in the chaotic nature of warfare.

Every military member, be it the most junior recruit going through entry level training, or the most senior officer at the pinnacle of his career, has experienced and been a part of a C^2 process. The most junior of our ranks probably have not thought about their duties and how they

fit into the larger picture in these terms, but the process directs them in their actions and they in turn contribute to its effectiveness. The mechanisms used to identify what needs to be done and seeing to it that appropriate actions are taken to accomplish the tasks for the platoon commander certainly differ than those of the JTF commander conducting an amphibious exercise, but each is involved in a process unique to their level of command.

4. Command and Control Systems

C^2 systems consist of applications, information management, and physical things that make up the information exchange and decision support subsytems used to facilitate the command and control process. Snyder points out that while there is a unique C^2 process for each commander, systems normally support the processes of several commanders. Decision-makers usually stand apart from the systems that support them but are a part of the system supporting superior commanders. (Snyder pp. 10-13) While conducting the research for this thesis it was interesting to note that most training and education conducted regarding C^2 focus on the tangible tools most commonly associated with systems. Computers, switches, terminals, and protocols are most often discussed because they are more quantifiable and fit nicely into the "science" of command and control as opposed to the less tangible "art" of the process. Truly integrating the systems into the process is a significant challenge that infiltrates functional areas, acquisition processes, organizational structures and the mind-set of all involved.

B. AN INTERACTIVE APPROACH

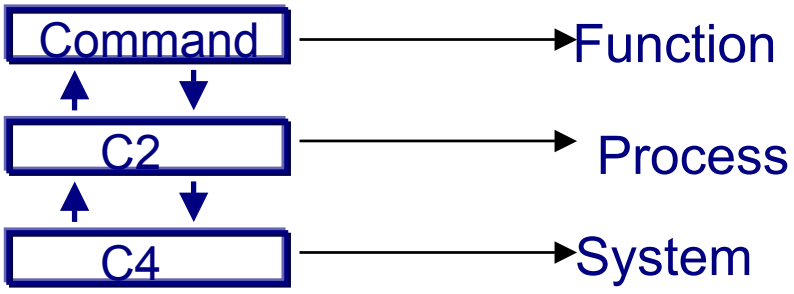

Figure 1. C^2 Component Interaction

The terms used, based upon the agreed DoD definitions, provide a foundation for further discussion. Figure 1 depicts the interaction of the C^2 components used for further exploration of the subject. The command function is implemented via a C^2 process and supported by various C^2 systems. Command is the primary function, but is insufficient without control in today's system intensive and technically oriented military. An effective process involves all parts working in all directions. The more seamless the integration between entities, the more effective the process becomes. The goal is a mutually supporting system of give and take in which complimentary commanding and controlling forces interact to ensure that the organization as a whole can adapt continuously to changing requirements. (MCDP 6, p.40) The components of the process have to work in a synchronized fashion, but it is the process that is critical in determining effectiveness.

C. COMPONENTS OF THE C^2 PROCESS

Decision making, at all levels, is the heart of the C^2 process. It is the people that drive the process and make the decisions in an effort to accomplish the mission. Figure 2 shows the components of the process and their interactions in support of the decisions.

People are the focal point of the process as they gather information, communicate, cooperate, and make decisions. The rest of the process exists only to serve them.

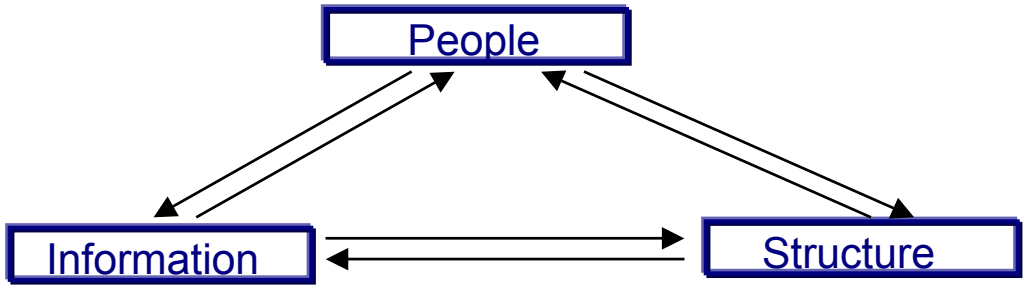

Figure 2. C^2 Process Components

Information is described in any number of ways but is defined as representations of reality, which is used to inform in the above process. This can be done using words, letters, numbers, images and symbols to represent things, events, ideas and values. Some replace "information" with "technology" in describing the process, depicting information, as a subset of that component. Technology can facilitate information gathering and dissemination, but it is not required to obtain information. Certainly

technology has an important role as it allows for the flow of information in all directions. Its level of importance is dependent on which echelon of command one is operating at.

Structure aids the people who create, disseminate, and use information. It includes organizations, procedures, equipment, facilities, training, education and doctrine. Although these things are designed to assist people in the process, poor design and a lack of understanding, training, and education, can cause the opposite affect. The same holds true for a dysfunctional organization as the decisions made regarding organizations affect all other types a commander will face.

One can conclude that the process is only as strong as it's weakest component. People who do not understand the information requirements or how to disseminate critical data, hinder effectiveness. Representations of outdated or improper information can also have devastating affects. Creating a process where people know what they need to know and understand the structure in such a way as to optimize information flow is the challenge that each of us face in every C^2 process of which we are a part. It is a dynamic system that requires attention and care, but one that offers significant dividends when we are more effective at it than our adversaries.

The components of the C^2 process require constant interaction and are not isolated from external factors impacting overall effectiveness. Figure 3 is used to represent how the components of the process fit within the C^2 framework.

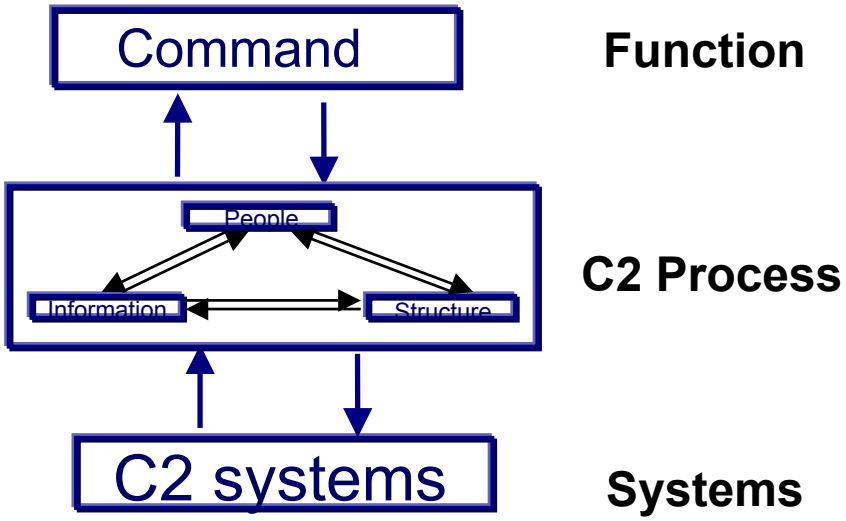

Figure 3. Overall C^2 View

The environment in which the process is functioning and the technology being used to support information gathering and dissemination both create challenges which the process has to adapt to and overcome. These issues are discussed in further detail in subsequent chapters.

D. DOCTRINE DEVELOPMENT

A formal analysis of the doctrine development process is not required for insight into the topic of command and control. The inclusion of this section stems from exploring current DoD publications and the writings of the recognized authorities on C^2. Military theorists such as Van Creveld, Sun Tzu, and a handful of others influence all current publications on the topic as evidenced by their bibliographies. It is not hard to deduce which publication

were signed first as all that follow cite those that came before. This begs the question, "Who actually develops C^2 doctrine and are they equipped with the tools to accurately capture it's importance?"

Action officers, contractors, and fleet input all contribute, but the experts among them may be few in number. The changing face of warfare and the immersion of technology in every facet of our operations demands that the institution invest in education on the C^2 process to meet future challenges head-on.

E. SUMMARY

The command function is implemented via C^2 processes which are supported by various C^2 systems. The process is influenced by the technology used, and the environment in which it is operating. This conceptual model of the process is the common denominator that can be extracted from the doctrine, C^2 authorities, and various publications cited, and the heart of command and control. Command and control is a process describing what a leader or commander does transposed by several categories of tangible resources. The goal of command and control is not limited to a single objective but centers on decision making in order to accomplish the mission while reducing uncertainty in a timely manner. (Coakley, pp. 24-27) People are the key to the C^2 process and are supported by information and structure.

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III. C^2 PROCESS

A. INTRODUCTION

Having taken a look at the doctrinal definitions and identified the functions associated with command and control, focus now shifts to the process and its components. Exploring the activities of the process is necessary to fully comprehend what occurs within the C^2 domain. To accomplish this, two representative models will be used as a mechanism to better understand the process and the interactions occurring between components. These models represent what takes place during the C^2 process, which is cyclic in nature and occurs almost continuously. We are often asked to think "out of the box" as we contemplate the future of warfare. Understanding what's in the box prior to embarking upon such an ambitious task will help to minimize turbulence during the journey. Reflection on warfare over the ages and how it has evolved provides insight into some of the challenges we face in the future.

B. BOYD'S OODA LOOP

Arguably, the most recognized model for exploring the C^2 process within the military is the one developed by Colonel John Boyd, USAF (ret) based on his experiences as a Korean War fighter pilot. A decision-maker must "observe" what is happening, "orient" what he sees with what he already knows and what he wants, "decide" what must be done and then "act" to implement his decision. Once action has been taken, the loop begins again. Boyd's OODA cycle is part of the tactical decision loop. The idea is that the

commander who can complete the loop faster in battle has the clear advantage. By operating faster than the opposition, a commander can react more rapidly to changing events and control them. By progressively complicating the opponent's decision cycle, one can eventually collapse the adversary's C^2 system and defeat him. Boyd describes it as a continuous "organic" process, as much of the loop takes place within the brain of the commander or decision maker. (Boyd, p. 26) Figure 3 shows the Boyd model.

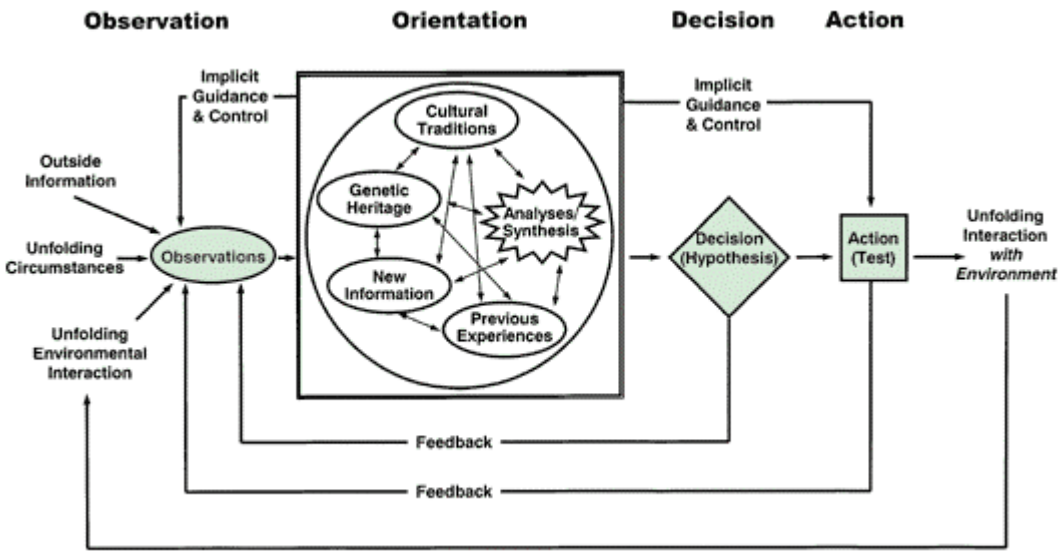

Figure 4. BOYD OODA LOOP (from Boyd, p. 26)

Commander's at all levels each have their own particular OODA loop, all operating simultaneously, but not in a synchronized manner or at the same rate. Each loop is constrained by the speed of loops below it and in turn constrains the speed of the loops above. Boyd's model can be applied to the ground commander as well as to the fighter pilot engaged in air-to-air combat, but it may not be applicable in all organizations and situations.

1. Dissecting Boyd

To better understand the model, consider the actions taking place as really two separate cycles operating at the same time. The first is the information-gathering cycle, consisting of the observe and orient steps, and addresses the commander's need to find out "What is actually happening?" This is accomplished primarily through interactions with the operating environment which consists of everything outside the process. The second process, consisting of the decide and act steps, is the decision-making cycle, which focuses on the commander's need to decide "What can or should be done about it?" (Roman,p.8)

A commander who has a very effective information-gathering cycle, but who defers a decision, refuses to make a decision, or makes the wrong decision creates an imbalance in the process. While the ability to observe and orient is high, this cycle is turning faster than his ability to decide and act on the information obtained. Even though his uncertainty is low his actions are counterproductive to his subordinates because his command decisions and abilities to direct appropriate actions are flawed.

Now consider the commander with a poor information gathering cycle, offset by an ability to decide and act correctly at the right time with limited information. Inadequate information gathering that is overcome by experience, training, and procedures again creates an imbalance in the system. No matter how qualified and

capable a commander, he will eventually make a poor decision given untimely or inadequate information.

It is critical for a decision-maker to operate faster than or within an adversary's OODA loop. It is equally important that a balance exist between the information gathering cycle and decision-making cycle as the two define the operating tempo and determine the amount of uncertainty in the system. Our ability to out-think our opponents hinges on the balance we create between these cycles within the C^2 processes. As we strive for faster decisions through the use of faster technology we must guard against sacrificing balance. Decision-making, and the challenges associated with it, is discussed in detail in chapter V.

2. Impact of Technology

The ability to observe, orient, decide, and act faster than one's opponent will continue to be a necessity in future warfare. History has shown that the tempo of operations caused by the impact of technology in warfare has accelerated. One such example is the number of radio sets to soldier ratio. In World War II there was one radio for every 38.6 soldiers. This number rose to one radio for every 4.5 soldiers in Vietnam, an 857 percent increase. (Van Creveld, p.238) As technology has improved and our reliance on it increased, the time for commanders to gather information and make decisions has decreased. The time differential between information gathering and decision making has compressed to a point where they can no longer be sequential actions, much like the command style used by Alexander the Great, but must be simultaneous and

continuous. This increases the likelihood of imbalance as the commander's ability to orient himself and gain situational awareness diminishes in an effort to keep decision making up to speed with information gathering.

The technology also serves a mechanism to enhance interactions with the environment. Boyd's model does not set out to influence the environment, but to observe what is taking place in the battlespace. Enemy actions, weather, and terrain may change the data we obtain from the environment, but the focus remains on outpacing the opposing commander in developing situational awareness, developing and selecting a course of action, and issuing orders.

The commanders at the lowest levels, who are able to observe their units in action and gather there own information based on the environment, most likely employ a C^2 process that closely resembles the one described by Boyd. Commanders removed from the fight with larger organizations will rely more heavily on technology to gather information. The relative simplicity of the OODA loop, although having great intuitive appeal, may not be adequate to explain all of the command and control activities occurring at all levels. Because of this, other detailed models, like The Lawson example, were developed to offer greater clarity and precision.

C. THE LAWSON MODEL

The Lawson model, as shown in Figure 5, is based upon the concept that the purpose of command and control is to either maintain or change the surrounding environment.

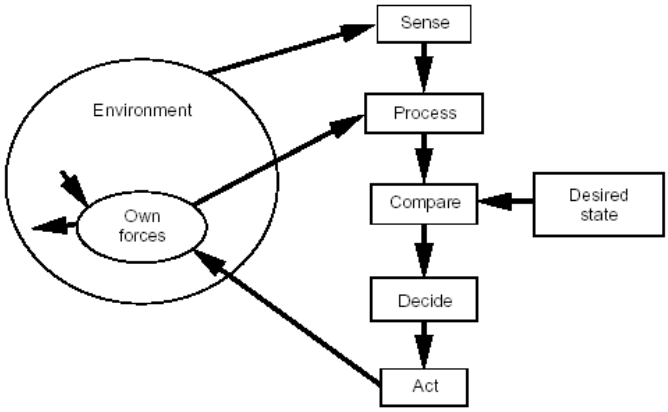

Figure 5. Lawson Model (from Coakley, p.33)

Lawson introduces several additional items to amplify this point. First, the "observe" block from Boyd's model has been expanded into "sense" and "process." This more discrete approach is useful when viewing the C^2 process as one that is more distributed, incorporating multiple sensors that produce data.

The "compare" step is similar to the "orient" step used by Boyd and examines the current state of the environment against the desired end state. This requires the commander to intellectually interpret the information received and decide what is to be done to change the environment to his advantage. (Coakley, p.33)

Once the decision is made, the "act" step occurs as subordinate units receive their orders and execute their tasks while monitored from higher headquarters. As this occurs, some change is made to the environment and the cycle starts again. This model can also be interpreted in the information gathering and decision-making cycles that we applied to Boyd's model, but Lawson's focus on the

environment is where the difference between the models is the greatest.

1. Focus on the Environment

Lawson's model is slightly more complex but provides a more precise sense of how the environment affects various levels of the command and control process. He also acknowledges the fact that our actions must be conducted realizing that the enemy is also acting to change the environment.

Lawson adds ones own forces to the environment where they are capable of influencing that environment. Their actions or reactions to enemy forces will change the information developed from the previous cycle in the upcoming "sense" module. The environment also includes enemy and allied forces whose actions also change the environment. Weather, terrain, geo-political concerns and other items are also included in the environment.

Technological factors also play a role in the Lawson model. Just as we employ technology to facilitate the decision-making process, the enemy is also sing technology in an effort to reduce their decision times. Asymmetrical warfare requires us to consider the abilities of our adversaries to disrupt and deny our technology through information-based operations. Their ability to manipulate the automated tools we use for data collection and information processing would negatively affect our operating environment and disrupt our ability to command and control.

Lawson asserts that "to talk about a completely integrated C^3I system is ridiculous. Its various parts must be pretty much self-contained and perform definable and separable functions so that we can change one module without affecting all others." (Signal Magazine, 1979) The requirement to change a module would be driven by the desire to change the environment or a change required to deal with the environment.

2. Model Summary

The effectiveness of these models depends on one's frame of reference. Both illuminate and obscure issues important in the study of the command and control. Boyd provides a simpler model that tends to focus on the opposing commander. This concept, although applicable for any facet of warfare, may be more conducive for the tactical operator focused on outsmarting the enemy. Lawson's model is more complex and focuses on the relationship between the environment and the process and how a change to either affects the other. It applies steps that favor technological approaches to information gathering and most likely resembles the process occurring in larger and more complex organizations. Both are subject to process variances through the use of technology and uncertainty of the environment. These can have both positive and negative affects on the C^2 process and effectiveness in pursuit of mission accomplishment. A look back at the evolution of warfare is useful in understanding these models and their applicability as technology develops and the uncertainty of the environment increases.

D. HISTORICAL PERSPECTIVE

Van Creveld recognizes that command and control is as old as warfare itself. From ancient armies of the Israelites and Alexander the Great to today's forces engaged in fighting terrorism, all have employed a command and control process. The role of technology, organizational structures, and their societies shaped how they commanded and determined the type of processes they used. The earliest combatants referred to the C^2 process and functions as simply "command" functions. For thousands of years command covered everything that is now associated with command and control. It has not been until recently, about the time World War II ended, that the term command and control began to appear in our vocabulary. Experts have various opinions on how command evolved into command and control, but most agree that the size of forces, operational characteristics, and functional complexity have been the primary factors for the migration. (Allard, p. 28)

1. Size of the Force

Warfare is basically mass organizations of armed men who do battle with other mass organizations of armed men in the pursuit of victory. Although victory is not always a function of force superiority, there exists the common perspective that more is better. Increasing the number of men increases the problems for command and control of them. The standard solution has been to create a hierarchical

organization with echelons of command and an associated rank structure.

With the growth of the force came the need to provide overarching guidance and coordination for the functions needed to support the warfighter, hence the birth of the staff. General J. D. Hittle, in his book *The Military Staff: Its History and Development* stated:

> When some unknown warrior chief asked for help or advice from one of his co-belligerents, military history saw the first functioning of the military staff. (Allard, p. 29)

The need to extend the commander's span of control to carry out the functions of command through the use of staff became a natural progression as the size of the forces commanded grew.

2. Operational Characteristics

As armies grew and capabilities developed, the idea of combining functions to project a more lethal force emerged. Although the nineteenth and the twentieth centuries elevated the principles of combined arms, ancient armies incorporated these ideas through the use coordinated use of infantry, archery, and cavalry. These varied capabilities and difficulties in coordinating them, increased the need for the personal control by the commander. This too, added to led to echelons of command and staffs to coordinate and control activities of forces across the battlespace.

Improvement of weapons and system capabilities requiring special skills also added to the challenge of command and the ability to control those involved with the

business of warfare. Shouted battlefield commands, the ability to observe the entire engagement and the opportunity for the commander to influence the fight diminished as operational characteristics became more complex. One only has to consider the number of specialties in today's military required to move, shoot, and communicate to understand the span of control issues a commander faces.

3. Functional Complexity

The operational characteristics of a growing force and the need to extend command authority often contribute to functional complexity. The more functionally diversified a large force is, the more complex the tasks of logistical support and operational employment. The need to achieve greater effectiveness through delegation and the desire to retain overall operational control causes a fundamental tension. To keep from instituting division of authority through a division of labor, commanders have always kept the reins of control as close as the situation would allow.

This desire for unity of command was facilitated through staff positions like the chief of staff, logistics officer, and communications officer and through subordinate unit commanders, as forces diversified and span of control capabilities of one person diminished. These factors complicated the command process and contribute to the migration from the term "command" to "command and control." (Allard, p. 30)

E. SUMMARY

It is the command and control domain that the models attempt to clarify. Central to the domain and C^2 is the process. Decision-making is the product of the process that puts forces into motion. People, information, and structure are the components of the process that are supported by systems to facilitate the command function. The more fully understood the domain, the easier it becomes to identify potential problems brought on by technology and changes to the operating environment. One's ability to study the process and identify strengths and weakness corresponds to how well the commander and the process deal with the uncertainty of warfare. The skills of those involved and the use of technology to build better situational awareness help the commander deal with things we anticipate, but do not know about the situation. It is stability and flexibility of the process that will be the driving factors in handling issues that one did not know that they did not know.

IV. ORGANIZATIONS

A. INTRODUCTION

> Order or disorder depends on organization. (Sun Tzu, 1993)

Organization(s) fall within our description of the C^2 process, as a subset of structure, but it is an extremely important element as decisions made regarding the organization affect all other decision a commander makes, as discussed in chapter V. Organizing includes setting up the unit, determining who talks to who, where information must flow, who may make what kinds of decisions, and what reports are required. Organization drives behavior of people who in turn drive the C^2 process, and the orientation of an organization determines, or is a product of the degree of uncertainty, a commander is willing to tolerate. Today's military organization must be adaptive to changes imposed by the environment as the face of warfare changes. Having stated why a discussion on organizations is so important, we begin exploration of the topic with some basic definitions.

B. DEFINITIONS AND ELEMENTS

Organizations are fundamentally social structures where an individual, in association with others, has the potential to reach certain levels of fulfillment that might otherwise be unattainable. Organizations supply both a condition and a context for dealing with our various environments. Organizations represent a culmination of social order that links the individual to a collective body

that in turn provides a service to the individual while it simultaneously serves the society. Schools, police departments, and the military are examples of organizations whose character is to gather the interests, needs, and desires of people into an entity that represents what it is they want. (Strategic Leadership and Decisionmaking, p. 3)

Organization serves an important function of providing sources of group identity for members of the organization. An organization operates most effectively when its members think of themselves as belonging to one or more groups characterized by high levels of loyalty, cooperation, morale, and commitment to the group mission. (FM6-0, p.5-22) There is no universally agreed-upon framework for classifying successful organizations, but many experts on the topic agree that Mintzberg's recent work comes closest to identifying commonalities.

C. COMMON ELEMENTS

Theories regarding the elements of an organization exist ad nauseam. One such theorist, Henry Mintzberg, argues that there are five basic parts to any organization. Each part described has some application to the military organization but there are friction points as there are no hard and fast rules for how an institution chooses to organize. Exploring the common elements described below provides insight into our organizations and potential changes we face as we contemplate our visions of the future. Mintzberg's elements are shown in Figure 4 and are defined in the following situations.

1. The Operating Core

Defined as employees who perform the basic work, the operating core is related to the production of product and services. In a military organization, the operating core can be thought of as the young soldiers, sailors, airmen and Marines who carry out the orders of superiors. Our business requires a young work force, and our operating core comprises the bulk of our forces. Clearly delineating what ranks fill the operating core is not an easy task as we require many of the operating core to perform other functions. This is true for most of Mintzberg's elements.

When control lies with the operating core, decisions are decentralized. When combined with standardization a professional bureaucracy occurs that is efficient, but requires a high level of specialized expertise in order to be effective. Conflicts can develop between subunits, capable of performing specialized tasks, due to narrow objective pursuit. This type of organization is best utilized when matched with a large size unit, operating in a complex and stable environment, utilizing a routine technology that is internalized through professionalism. (Robbins, p. 165)

2. The Strategic Apex

Flag officers, and the most senior civilian employees within DoD comprise the strategic apex of the military organization as they are charged with the overall responsibility for the organization. One could argue that in smaller units such as battalions, squadrons, or

individual ships, that the apex does not require flag officers. Those units, and the individuals in charge of them, do not operate in an independent nature, rather their actions are part of a larger comprehensive plan which directs their actions. This is especially true in today's joint environment.

When the strategic apex is dominant, control is centralized and the organization is a simple structure. Typically, these organizations are low in complexity, have little formalization, and have authority centralized in a single person. It resembles a flat organization with all functional areas reporting to one person where decision-making resides. It is a simple structure that is fast and flexible, and requires little to maintain. Accountability is clear and there are few layers of bureaucracy. It is limited in applicability as larger organizations do not fit well within this model. There is also little counterbalance to the central decision maker and abuse of authority can become an issue. (Robbins, p. 280)

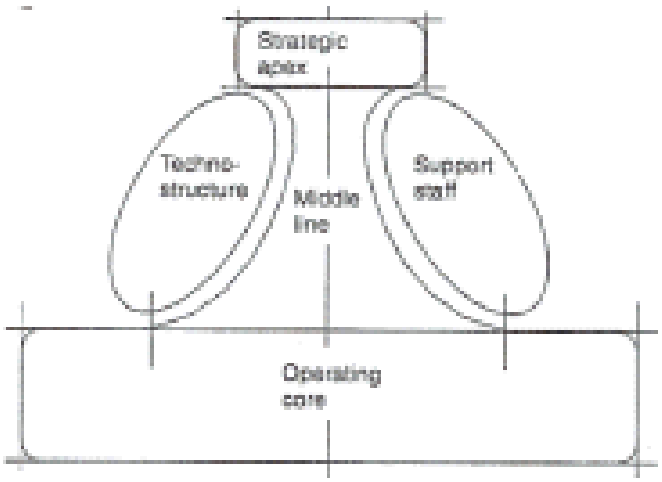

Figure 6. Mintzberg Elements (from Robbins, p. 279)

3. The Middle Line

The individuals who connect the operating core to the strategic apex are the middle line managers. Within our organizations we have a number of echelons with commanders who constitute this group. They are responsible for the their organization, which is a subset of the institution, and certainly contribute to the success of the institution, but they are not responsible for the entire institution.

Determining where to draw the line with regards to who fits into this category and who does not is not terribly important for the military organization. The squad leader may not have the same responsibilities as the division commander, but they each play an important role as part of this group. What is important, is understanding how this group interacts with the others and the dangers that can occur when individuals in the middle line act independently.

Theoretically, groups of autonomous units operate in a divisional structure, each typically a machine bureaucracy unto itself with highly routine operating tasks, coordinated by a central headquarters. Middle managers in this scenario are afforded a great deal of control. Goals of the functional unit tend to override those of the organization. More accountability is present as more responsibility is placed in the hands of the divisional manager. (Robbins, p. 283)

4. The Technostructure

Determining who has the responsibility for effecting certain forms of standardization in the organization is not as clean a process for the military as it is for the business community. To some extent, we are all responsible for adhering to standards but we are not all analysts as Mintzberg describes. Certainly those individuals with technical skill sets fall into this category, but they also are a part of another group, be it operating core, middle line, or support staff. The civilian component of our organization fits the description as well. So once again, there is some problem with a direct translation to the military.

Standardization is the key component of the machine bureaucracy, which is what occurs when the technostructure is dominant. Highly routine operating tasks and formalized rules and procedures, grouped into departments coupled with centralized authority, decision making along a chain of command and an elaborate administrative structure are its characteristics. Because of this, standardized activities are performed in a highly efficient manner but one runs a risk when confronting inflexibility as people may become obsessed with following the rules. Because units can work autonomously, conflict can occur as unit goals can override the goals of the organization.

5. The Support Staff

People who fill staff positions, providing indirect support services for the organization comprise this group. We are no strangers to staff functions and responsibilities

and the definition provided fits our organization well. In the military organization it is often the staff that writes and enforces operating procedures and standards much like the technostructure described above.

An adhocracy arises when the support staff is the ruling body. It is characterized by high horizontal differentiation, low vertical differentiation, low formalization, decentralization, great flexibility and responsiveness. Decision-making in this type of structure is decentralized as it depends on decentralized teams of professionals working together to make decisions. An adhocracy is useful when adaptivity and creativity are required that rely on the input of diverse disciplines in a collaborate manner to achieve common goals. Complex problems are also handled well by this type of organization. Adhocracy lacks the advantages of standardized work and can cause conflict as a result as there tend to be no clear boss-subordinate relationships. It is best utilized when the operating environment is dynamic or complex. Our battle staff configurations tend to fit within this description.

From this brief discussion, it easy to see that our organization often requires individuals to be members of two or more groups as described by Mintzberg. Attempts at categorization would have to consider such things as rank, billet assignment, training, and experience. It could also be applied for each echelon of command. The very fact that we require people to simultaneously be members of two or more groups is a strength of the organization that helps

give us flexibility and allows us to adapt to changes from the environment.

D. ORGANIZATIONAL PROPERTIES

Having taken a look at possible types of organizations and the elements thereof, it is necessary to describe internal organizational properties prior to examining the military bureaucracy. The first of these properties is complexity. Organizations are complex because of the scope of work, variety of people and operating environments, the relationships with the environment, and the differences between the divisions within the organization. The mix of task, people, communication, problem solving and decision-making, and their permutations and combinations contribute to the complexity.

Surprise is the second property of organizations. Predictions of the impact of plans considered in reaching a decision are not fully reliable. Actions or decisions of a leader may be misinterpreted if not articulated properly leading to unanticipated actions by other members of the organization. Poor policies, parochial views, and overstating the severity of problems can all contribute to procedural flaws that can have a negative affect on the populous and spawn unanticipated reactions.

Organizations are deceptive, in that structure, culture and practice frequently mask things that may really be occurring. Hidden information and massaging of analytical evaluation mechanisms in order to improve organizational perception are just two examples of the deception that may take place. This behavior is

particularly dangerous if recognized in the actions of the leaders by subordinates who may, adopt these practices in turn. Understanding what takes place in the trenches of the organization or what we in the military term leadership by walking around, may be the best mechanism to get the pulse of the organization and unmask the deceptions.

Organizations tend to be ambiguous. Trying to find out what is really taking place is complicated by such things as quality and reliability of information. Complete honesty may not be the driving factor for those desiring recognition and promotion. Interaction with the environment also adds to the ambiguity, but it is an interaction that is necessary for survivability and viability. (NDU, Organizational Processes and Leadership Requirements, p. 3)

E. OPEN SYSTEM ORGANIZATIONS

Today's military organizations exist in global environments that can be categorized as multifaceted, unpredictable, and complex. Since the organizations are so highly engaged with their environments, they are considered open systems. Successful organizations develop characteristics and perform processes that allow them to adapt to constraints, threats, and opportunities. They import capability from the environment and their actions affect the environments themselves. The capability is achieved by obtaining information needed to transform requirements into desired outputs such as services or operational actions. The transformation processes are cyclical in nature and somewhat predictable as observations

that drive the transformation are part of the C^2 process as identified in the models discussed. (NDU,Systems Thinking and Learning Organizations, p. 3)

An interdependency exists between the system and the environment. Changes in the environment affect one or more properties of the system, and, conversely, changes in the system affect its environment. There is a boundary between the system and the environment, which can be symbolic or physical, but ones does exist.

Theoretically, negative entropy can exist in such a system. The system can repair itself, maintain its structure, and even mature as it has the ability to import more energy than it expends. This input of energy tends to offset entropy and the system normally maintains some constancy in energy exchange. Even with a constant flow of new inputs and outputs, the character of the system remains the same. As an open system becomes more complex in an effort to fend off entropy, it tends to grow and expand. Prudent organizations operate within a margin of safety to ensure effectiveness.

Maintenance activities for equipment and personnel play an important role in the system as they seek stability and preservation of the status quo. Recognizing this, it is also important to recognize that adaptive activities are needed so that the system can adjust over time to variations in internal and external demands. A balance of maintenance and adaptability is key to the survival of the system.

Finally, open systems can reach the same final end-state through differing initial conditions by a variety of

paths. Understanding the elements and properties of organizations and the characteristics of an open-system will help in understanding the military bureaucracy and determining if we are organized in such a way that our interactions with the environment allow us to be as effective as possible.

F. THE MILITARY BUREAUCRACY

Defense bureaucracies produce tremendous quantities of information about the external environments in which they operate. Data gathered is transformed into information to support all levels of decision-making. But a potential problem exists. Government agencies, particularly the Department of Defense, use sets of standards to achieve stability and accomplish programmable outcomes. The organizational standards we have been using for decades may not be best suited for the information and technology based warfare of the future and the need to respond to potential environmental challenges. Change in the environment, rather than stability, is the norm. These changes can have strategic implications beyond the realm of any single decision-maker and require us to analyze the organization's ability to respond. The two most common type of C^2 organizational structures are hierarchical and networked.

1. The Hierarchical Organization

Traditionally, the military has been hierarchically organized because it requires less communications and substantially simplifies the planning and control functions. This approach attempts to turn the entire force

into an extension of the commander as subordinates respond in precise and standardized ways to his orders and provide him with the data necessary to control the entire force. (Roman, p.13) It also identifies which commanders are empowered to make which decisions. Connectivity is engrained in this hierarchy as information gathering and the passing of that information to higher levels, are procedures associated with centralized management of the battlespace. It is rigid in the sense that decision-making is under the personal control of the commander and the power associated with each level of command is a function of how much, and the kind, of information controlled. He determines what information to provide to subordinates. In an effort to eliminate uncertainty, C^2 is centralized, formal, and inflexible.

The very nature of controlling information defeats the optimum use of the information. At each echelon of command, information is gathered and decisions made before the information is forwarded up or down the chain of command. Some form of filtering, adding, deleting, and modification is done at each level, which is time consuming and can often result in the critical information not reaching the right people, or getting there too late. Controlled information becomes slow information, a perceived problem of cited by tactical users of information generated by the intelligence community. In attempting to get the right information to the right people on time, some degrees of freedom are required at all levels to better balance decision-making.

The technological advances we have enjoyed over the last couple of decades have driven higher levels of centralized control and subsequently decision-making. This may not be true in all situations, but it appears that a trend has in fact developed. This trend threatens ingenuity and initiative at the lowest level and requires trust in subordinates to overcome. Commanders, who have the technical capacity to centrally manage the battle, have been most successful when they delegate tactical responsibility and avoid interference in the authority of subordinates. (Roman, p. 14) The increased amounts of information require faster decisions to keep up with the increased tempo of warfare. Perhaps our hierarchical organization and control of information hinders our ability to accomplish this.

2. The Networked Organization

Organizations requiring faster decisions due to an ever-changing operational environment tend to take a decentralized approach. The networked organization seeks to accommodate this by accepting a reduced degree of certainty at the top to facilitate decision-making at the bottom. This is needed with this approach based on the desire to increase the amount of information available to everyone within the organization. The greater the degree of control, the less number of alternatives available for problem resolution. (Crecine and Salomine, p.50) The decentralized control fostered by the networked organization makes better use of technology according to several studies by the RAND Corporation and the USAF's Scientific Advisory Board. Theoretically, operations in

this type of organization are autonomous at all levels with the commander controlling only in the sense of directing a cooperative problem-solving effort.

A networked sharing of information is much different than that of the hierarchical control of information. When all levels of command share the same information, uncertainty may increase, but faster decision-making is possible. Troops engaged will have and generate more information than the headquarters. Chaos in warfare arises from adding more energy or information to the system. Those engaged must be empowered to use the information they generate, and that from other sources, for their decision-making in responding to local conditions. This does not come without challenges, as the need to balance legitimate requests for information while allowing commanders the freedom of action is a difficult one. (Roman, p. 16)

Modern technology makes the sharing of information at all levels possible. Practicality is another issue. If front-line forces need the technology, they will also need the support to make the technology work for them. Equipment strings, logistic support in the form of batteries, and technician support to install and maintain the technology we speak of, are issues to be wrestled with before this type of information sharing and networking is possible. Will the technicians required to configure and troubleshoot equipment become a part of the initial waves ashore? Does the bandwidth exist to support the requirements if we are to migrate to a networked organization? There are numerous difficult issues, like

these, that need to be addressed, if a networked organization is to be adopted for use by the military.

Information available to all in the networked organization raises issues of potential gaps and overlaps between units. Care has to be taken to ensure actions are not duplicated or not taken at all based on assumptions. A hasty response might be to apply some sort of filter, defeating the purpose of a networked organization.

Tough decisions are required for those in the military, especially for those in combat. Military commanders must make life and death decisions and put subordinates at risk on a routine basis. In a collaborative, networked environment, who will make the hard decisions and take responsibility for the outcomes? War requires commanders first, not collaborators. This does not preclude the commander from using collaboration and the associated tools, but the individual must eventually make the hard decisions. The military exists to be effective in pursuit of missions assigned, so the organization we adopt must first be effective.

3. The Effective Organization

The military exists to be an effective force in accomplishment of assigned missions in protection of our vital interests. Efficiency is desired as well, especially from the standpoint of the civilian oversight of DoD, who are trying to match requirements with available resources. But it is effectiveness that we must focus on as we evaluate our organizational structure and the future challenges we face. Characteristics of an effective

organization are as broad ranging and diverse as the study of command and control. Peters and Waterman's book, *In Search of Excellence*, does a good job of identifying eight common characteristics of Fortune 500 companies. They are:

1. They have a bias for action and getting things done.
2. They stayed close to their customers in order to fully understand their need.
3. They allowed employees a high degree of autonomy and fostered the entrepreneurial spirit.
4. They sought to increase productivity through employee participation.
5. Their employees knew what the company stands for, and their managers were actively involved in problems at all levels.
6. They stayed close to the business they knew and understood.
7. They had organization structures that were elegantly simple, with a minimal number of people in staff support activities.
8. They blended tight, centralized controls for protecting the company's core values with loose controls in other areas to encourage risk-taking and innovation. (Robbins, p. 52)

This research has received its share of criticism but it is a good starting point in evaluating current organization and recommended changes for the future. We are a force that relies on technology and this reliance will continue to grow as we prepare for engagements of the future. It will be necessary to craft an organization that has the proven effectiveness of the hierarchical model while taking advantage of the technology the networked model provides.

G. THE FUTURE C^2 ORGANIZATION

Considering our current organization, the need to share information at all levels, and the responsibility to remain an effective fighting force requires some changes to current configurations. The goal is an organization that combines decentralized decision-making (flattened-hierarchical), which is facilitated through shared information-gathering and dissemination (networked). Development of such an organization, and more importantly, the cultural change that would be required to make such a change successful, is easier said than done.

Some interesting dynamics occur when once considers how this is to be accomplished. Eliminating layers of command between the commander and the operational forces may facilitate the execution of decisions by the commander, but it may not cause decisions to be made any faster. Multiple units reporting directly to an operational commander increase the information load on that commander. A vicious loop can develop where the commander becomes slave to the computer. It is also unlikely that we will face an enemy technically superior to us. Turning inside our decision loop faster than the enemy may not be our primary concern. To only think about speed of the process may lead us to prompting and responding to our own inputs which will fracture situational awareness and increase uncertainty. Maybe the focus should be on what to do once inside the enemy's decision loop. Increased time for analysis and appropriate response would be the prudent course, even though this will slow the decision and execution steps of the C^2 process. Our goal then, should be

not speed of the cycle, but having the ability to control the rate of loop as some situations will require faster decisions, and others, a more cautious and slower approach. Some would argue that when having superior technological advantages over our enemy we should improve our decision-making loop by extending it, not shortening it. To do otherwise would only cause us to make several poor decisions to his one.

Span of control issues emerge with the removal of intermediate echelons of command. How much one person or one staff can actually control in this type of organization will depend a plethora of things associated with the actions occurring at that time. An approach must be adopted that ensures voids are not created as span of control becomes more difficult. Unity of command implemented via mission type orders is not a new concept, and will help address such issues, but will commanders and subordinates be disciplined enough to allow the degrees of freedom necessary with this approach? Command by negation concepts, where subordinates only require direction and guidance when working outside the scope of the commander's intent may be adopted, but danger lurks as personal interpretations enter the equation.

Eliminating layers of command will also require the technology to extend the information flow to the lowest operational units. Equipping every person or fire-team with equipment needed to work in the information dominated environment increases technical and logistical support. Correctly implemented, a networked force would increase lethality and effectiveness. Incorrectly implemented or

poorly supported, it could have unit commanders operating in the blind, which would hamstring commanders at all levels. The reliance and dependency instilled in commanders on the technology to make decisions may diminish the flexibility, ingenuity, and initiative imperative to the decentralized decision-making we expect when commander's intent has been clearly articulated through the hierarchical organization.

1. Recommended Approach

Perhaps in building the C^2 organization of the future we should focus on synchronization as a goal. The technology being used will require training for all those involved. These individuals, regardless of rank or echelon, could also be considered part of the technostructure we described earlier. Familiarity with the networked systems will take time for users, and those required to support. Synchronization might take longer to develop in an interconnected and operationally dispersed organization. It also requires increased organizational knowledge by those within the unit. This leads to improved performance through self synchronization. Increasing lengths of billet assignments may be a mechanism to overcome some of the obstacles mentioned here. The idea stems from the consistently superior results reserve units obtain in yearly tank gunnery contests. Almost without exception, the winning crews are from reserve units who have worked together on the same system for years. Adopting this approach may give us the best opportunity for success when organizing to leverage technology and decentralize decision-making.

This approach is not without challenges from operational and personnel tempos, but could be possible with the removal of intermediate echelons of commands. The task-organized force of the future may be conducive to such an approach.

H. SUMMARY

These are just a few, of the multitude of issues, facing our military as we articulate our future operational vision and is worthy of a thesis dedicate entirely to exploring possible options and recommendations. Our military organizations naturally resist change and overcoming the social challenges may be our biggest obstacle as we attempt to organize in such a way that takes advantage of a networked organization while maintaining a hierarchical decision-making concept.

The challenge for us is to build a force capable of operating effectively in the information-dominant world we live in now and will continue to pursue in the future. Understanding the theory of organizations along with our current structure will help us deal with the challenges that lie ahead. In maximizing the advantages available through technology, any attempt to reorganize must be one that retains the emphasis on command and not control.

V. DECISION THEORY

A. INTRODUCTION

The organizational framework, which can be thought of as the chain of command, will influence decisions made by the commander as the C^2 process is executed. Decision-making is the heart of the process, and the effective command and control we speak of is only possible with timely decisions and actions. Decision-making is a large measure of the art of command, as command responsibilities are fulfilled by decisions made and leadership. In working through the decision-making process, the commander analyzes current state, the desired end-state, and the transitional state. The desired end state must be clearly defined before putting decisions into action as a mechanism to track progress and control forces in pursuit of that state.

Decision-making is still very much a human endeavor. Advances in technology to assist the commander such as computer-assisted logic tools and artificial intelligence have not progressed as rapidly as information gathering technology. As more and more information is made available, the decision maker's ability to process and act on that information depends on many factors including experience, stress level, and his intellectual process. As Van Creveld states:

> The paradox is that, though nothing is more important in war than unity of command, it is impossible for one man to know everything. The larger and more complex the forces that he commands, the more true this becomes. (Van Creveld, p.109)

This statement and its validity have implications on decision-making and the techniques used by the commander in arriving at them.

The commander, when making decisions that can be categorized as organizational, informational, or operational, uses intuitive and analytical approaches. Exploration of these approaches and the types of decisions a commander is faced with will reveal that in practice, a commander will use a variety of techniques in making decisions. The true evaluation of the commander is not the techniques he uses, but whether his procedures were appropriate for the situation. It is the artful combination of intuitive and analytical decision-making that largely determines appropriateness of decisions and ultimately effectiveness.

B. ANALYTICAL DECISION-MAKING

The traditional approach to decision-making is one that generates several alternative solutions, compares those alternatives to some set of criteria in determining value of the outcome, and selects the best approach. Course of action development, analysis, and selection is an example of the analytical approach. The goal is to produce the optimal solution to the problem from those feasible solutions identified. Analytical reasoning applied in a methodical fashion is the approach taken when tackling problems that require analysis and are not time critical. It is an approach best guided by an experienced commander or staff who can break tasks down into recognizable

elements. For the less experienced it provides a methodology to work within.

This approach works well for the commander working in a complex or unfamiliar environment as it ensures they consider, analyze, and evaluate all relevant factors. Those decisions requiring significant computational effort are also best served through this approach. It also serves as a mechanism for resolving conflict between available recommendations. This approach is a time-consuming evolution as it often requires participation from staff and subordinates. Each service has its own particular planning process that grows in scope and size with each echelon of command. Decision-making during execution is not well served by this approach, as time becomes a constraint when we attempt to execute our C^2 processes faster than our opponents. (FM 6-0, p. 2-12)

Heavy reliance on staff and subordinate commanders to develop courses of action is common-place amongst the services. It is not unusual for a commander to be briefed on the recommended courses of action without participating in the planning process. More than once a course of action selection brief has turned into a commander's intent brief because the commander was busy controlling the execution of ongoing operations and was not intimately involved with the details of the upcoming operation. This can increase the time required for decisions to be made and negatively impacts effectiveness. There is an appropriate time for this type of approach to decision-making regardless of the impact of technology or our future organizational structure. As we work to increase information flow, remove

levels of hierarchy, and decrease decision-making time in future engagements, finding the resources to accomplish this, and the commander who is able to extract himself from current operations, may hinder its utility.

C. INTUITIVE DECISION-MAKING

Intuitive decision-making focuses on assessing the current situation rather than analyzing courses of action when time does not allow for an analytical approach. It is an act of decision-making that emphasizes recognition based on judgment, knowledge, experience, education, intellect, boldness, perception, and character. Intuitive decision-making is emphasized in a chaotic environment because uncertainty and time drive most decisions. It relies on an experienced commander's and to some extent, staff's intuitive ability to:

- Recognize the key elements and implications of a particular problem or situation
- Reject the impractical
- Select an adequate course to address the problem (FM 6-0, p.2-13)

It is a "gut" feeling approach that can serve as a substitute for missing information, provide some assistance when acting in uncertainty, and significantly speed up the decision-making process. It strives to find the first solution to solve the problem, rather than waiting for the optimal solution and is considered an art when done correctly. It recognizes that there is no absolute "right" answer as the commander is unlikely to have complete and perfect knowledge of the situation in a time-sensitive

atmosphere. General Patton addressed battlefield problems in this way:

> *A good plan violently executed now is better than a perfect plan next week.* (George S. Patton Jr, as quoted in NDP 6-0, p. 24)

In replacing analysis with experience and judgment, and monitoring only a few variables, faster decisions are made. This faster approach based on only a few variables supports the theory that war is ultimately an art rather than a science. In reality, commanders incorporate analytical methods when time permits rather than intuitive decisions as, no matter how good a commander is, he will eventually make a bad decision with inaccurate or incomplete information.

Commanders do in fact use a combination of approaches in reaching decisions. Determining which approach is appropriate is largely a function of time available, situational awareness, and level of uncertainty that is acceptable.

D. DECISION-MAKING IN PRACTICE

Many theorist believe that military decision-making is a two stage activity in which the first stage is recognizing the class of the problem, followed by applying specific problem solving techniques indicated by the problem structure. They believe problem solvers learn a number of problem-solving templates, which contain procedural information including indicators as to which template is the appropriate one to apply, types of information needed for generating alternate solutions, and

procedures for implementing solutions. (Orr, p.55 citing Dennis K. Leedom) Recognition of the class of problem can lead to either an analytical or intuitive approach, but more often than not the two approaches are not mutually exclusive. Intuitive decisions in the form of best guesses and estimates are often made in conjunction with a larger analytical process as we attack large, complex problems by breaking them down into smaller components. The reciprocal of this is also true. In dealing with the organizational, information, and operational decisions that commanders are faced with, most incorporate a number of templates and use both the approaches discussed.

E. TYPES OF DECISIONS

In discussing the types of decisions that commanders face it is necessary to understand the relationship between the three mentioned previously. Although it is the operational decision and the employment of forces that is normally associated with commanders, this type of decision cannot be made before organizational and informational decisions. Organizational decisions impact the other two types by establishment of information flow and a chain of command in which to carry out the actions in pursuit of the desired end-state. Informational decisions precede operational decisions and address the current state, incorporating information from the environment in which forces are operating. Figure 7 graphically depicts the relationship between the types of decisions discussed.

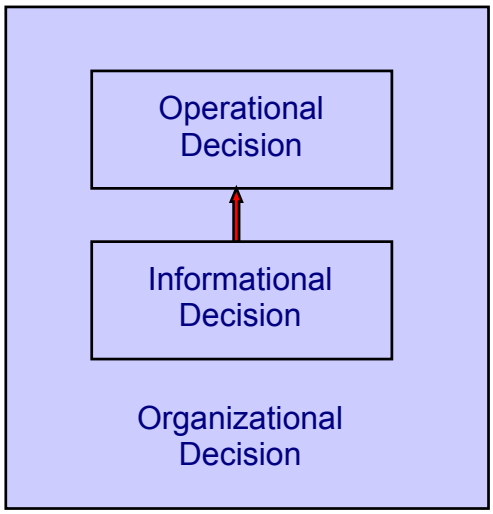

Figure 7. Decision Type Interaction

1. Organizational Decisions

Beyond establishing a chain of command and a chain of responsibility for success or failure, organizational decisions establish "who decides what" through the establishment of a C^2 structure and specifying what role each commander is to play in the process. Finally, organizational decisions establish the function that systems are expected to support. (Snyder, p. 42)

Few commanders have the luxury of making the organizational decisions that effect informational and operational decisions. As a result, the flow of information and the chain of command are fixed entities that they have to work within. So even though each commander employs a unique C^2 process, it is influenced by the structure that is in place as a result of others' decisions. Some implications that can arise from this are

limited resources from which information can be obtained and the inability to maintain unity of effort when forces required are not at a commander's disposal.

This brings us back to the discussion of organizational changes to take advantage of technology, improve information flow, and remove intermediate levels of command in pursuit of network-centric operations. Instead of technology fitting within the organization, we are actually talking about technology decisions driving organizational decisions, which will impact the informational and operational decisions. Caution is called for as we move in this direction. The technological solution designed to work within existing organizations is much easier than changing the organizations to take advantage of emerging technology, but can we afford to continue to do business in this fashion?

2. Informational Decisions

The organization will define how we obtain information and how the flow of information will occur. The information gathering steps of the C^2 process are largely about gaining situational awareness or understanding the current state in which operations are occurring. As Snyder points out, 'Commanders make decisions on the basis of what they believe is happening.' (Snyder, p.28) What they think they know is directly tied to previous experience, training, and cognitive skills, which help shape the decision-making templates. Decisions made on how a commander sees the current situation will always be biased

to some extent and may not accurately reflect what is actually happening.

There is also no such thing as real-time information, near real-time maybe, but not real-time information except for those front-line commanders making decisions from the trenches. Situational awareness is based on recent events, but can't address events occurring now. Anticipating events and speculation accuracy improve with credibility of information and an experienced commander who relies on his intellect to incorporate these concepts into his decisions. A commander's confidence in what he thinks he knows plays a role in types of operational decisions. One who is confident is more likely to make bolder decisions than one who questions the information he incorporates into his view of the situation.

Now consider the informational decisions of a commander in an organization that has flattened the hierarchy and increased information flow via technology. A small operation with few units involved will present the same issues as described above, but a large operation with many units complicates the informational decisions a commander will face. An intuitive approach would almost certainly be used, but will the commander be able to identify the relative variables? One possible solution would be analogous to how we view Monday Night Football. Producers behind the scenes see ten or twelve screens from various cameras viewing the game. The Executive Producer decides what we get to see. It is possible that a commander could use the same techniques, but this seems to counter the purpose of a networked organization as people

would still be filtering and modifying information before the commander gets to see it. This leads to several other important topics such as experience and training of those individuals behind the scenes, which will be addressed later in the thesis.

Recognizing that most individuals are capable of dealing with approximately seven pieces of data, plus or minus two, information overload remains an issue for almost any operation in which the commander is working to gain situational awareness. Credibility of information remains an issue for the commander as well. Trusting the selection of the key variables or the critical battle to technology or staff may not be the prudent course. An Enhance Combat Operation Center experiment conducted several years ago at the Marine Corps Air Ground Combat Center in Twentynine Palms, CA illustrates this point.

Two officers, one new O-3 and one two-star flag officer, from combat arms specialties were evaluated on their ability to obtain situational awareness in two different types of combat operation centers. One was entirely digital with tracks of forces being collected and collated behind the scenes with relevant information being presented on elaborate screen in the Combat Operation Center (COC). The other consisted of map boards, grease pencils, and lots of voice communications over traditional communication paths, not unlike the way we have been doing business for decades. In the digital COC the youthful O-3 outpaced the flag officer on all measureable aspects of the experiment. He quickly gained situational awareness of the operating environment and did not hesitate to make

decisions based on what he believed was happening. The flag officer, on the other hand, did not gain situational awareness near as quickly, and his decisions were calculated and slow as he insisted on additional information almost constantly. He was not confident in the information he was presented and sought confirmation through other means.

The traditional COC produced almost the opposite effect. The two-star officer almost immediately had situational awareness and keyed in on critical information requirements that had most observers in awe as he diagnosed the problem he faced, and quickly made decisions that proved to be correct. When asked how he knew what situation to key in on, he responded that "the inflection in people's voices over the radio's and his own experience" had guided him towards situations that needed his immediate attention. The O-3 performed much the way the two-star had in the enhanced COC. His responses were slow and sluggish, lacking confidence and requiring almost constant confirmation of what he believed was happening.

This rather lengthy illustration identifies some critical items that we need to pay attention to as we pursue organizational change. First, we must adopt a crawl, walk, run approach to develop the confidence and experience with the technology to keep us effective. Second, we must not abandon our current and proven techniques for commanding, as they have served us well in pursuit of accomplishment of objectives and mission.

3. Operational Decisions

In our way of thinking, the "rubber meets the road" with operational decisions. Understanding now, how organizational and informational decisions affect operational decisions, we can better understand the issues concerned with which course of action to take. In deciding how to proceed to accomplish the mission, the commander considers his objectives, enemy options, outer limit of his rules of engagement, and his level of confidence regarding situational awareness, all in the face of uncertainties about the future. It is easy to understand, based on the analysis above, why operational decisions are considered an art. When deciding on what course of action to pursue a commander considers whether it is suitable in accomplishment of the mission, feasible in accomplishing it with available resources and in the face of opposition expected, and acceptable if its cost does not exceed the value of the objective gained. (Snyder, p. 58 & 61)

The competence of a commander is tested by operational decisions, and as previously stated, it is not the mechanisms or procedures he uses, but the end results in accomplishment of the mission that count. All previous decisions contribute to the success or failure of a commander, but it is the operational decisions that we consider most important in time of war. Based on what we have covered, one must ask if this is a fair measure with which to evaluate commanders?

As we move forward in our tactics and techniques to leverage the technology, the implications of information have to be considered. What will be the mechanisms that

keep one front-line commander from acting on information more relevant to another? In theory, tactical commanders will have access to the same information available at the strategic level and could make operational decisions with strategic implications. Controlling this may require very defined missions that offer very little flexibility to the tactical commander. The opposite scenario also exists. A tactical commander often uses intuitive decision-making in the prosecution of objectives and mission. In doing so, he may not be able to take advantage of the information available, which could also have implications well above his level. Change is not easy and the solutions to these challenges must come from within if we are ever to realize our future visions. Operational decisions largely determine our effectiveness and our organizational and informational decisions must support the efforts of those charged with making the "up-close and personal" operational decisions as we prepare for the future.

F. SUMMARY

This chapter of the thesis addresses the heart of the command and control process, decision-making. Analytical and intuitive approaches, or some combination thereof, are used in making organizational, information, and operational decisions. It is not hard to understand how organizational decisions affect information flow and ultimately, operational decisions. The challenge for those of us who participate in the processes is to understand where our military is headed, think about the C^2 challenges we will face, and contribute to what needs to be a methodical

approach to solving these challenges. They are, in fact challenges, as the talent we maintain amongst our ranks is phenomenal, and can overcome most any obstacle given the right resources. Perhaps just educating our peers, seniors, and subordinates is the first step.

VI. BUILDING EFFECTIVE COMMAND AND CONTROL

A. INTRODUCTION

The previous discussions make reference to "effective" command and control. Having an effective process, in pursuit of mission accomplishment, enables decision-makers to build situational awareness in the face of uncertainty and time constraints as they decide what course of action to pursue. Effective C^2 depends on the capabilities of the people in the process, they are the most important dimension. It is the people who are the basis of military organizations, and all operations that occur require human interactions of some sort. The systems exist only to serve the people in the process, but they do not eliminate or lessen the role of humans. As our reliance on technology increases and information is made available to the lowest level, it is the people who will use their cognitive skills to overcome some of the obstacles we have mentioned. People are the key to continued superiority.

The uncertainty and disorder of combat requires that we capitalize on the unique human abilities of initiative, boldness, creativity, judgment and strength to gain and maintain the advantage. The commander is largely responsible for creating an atmosphere that recognizes, fosters, and seeks these qualities, which are essential to seize and exploit opportunities to maintain the combat advantage. Recognizing that people are the key to the process, it is the commander who is the lynchpin of building effective command and control. It is the people, not the technology, that are the key to building an

effective process and maintaining superiority. Understanding how to develop effectiveness in people begins with the commander.

B. THE COMMANDER

The commander provides the art of command and combines it with the science of control to achieve desired results. Command resides exclusively with the commander and consists of authority, decision-making, and leadership. Control is how the commander executes command. His abilities, based on numerous variables, largely determine how effective the commander is in his endeavors. Subordinates' performance unquestionably contributes to effectiveness, but their abilities are significantly influenced by the commander, in his understanding of the situation, his communication techniques, and his adeptness in directing their actions to achieve desired results. Effectiveness is a function of human performance in the commander and those involved in the C^2 process. The abilities of the humans in the process to apply the science and artfully orchestrate effective outcomes, determines how the mission is accomplished. Creating a positive command climate helps develop the effect we seek in the process, people, and outcomes. This begins with the commander's ability to understand his people and organization as well as the operating environment, as a result of information gathering.

1. Situational Awareness

Situational awareness is attainable through the integration of information received from human and

technological collectors. Looking inward, a commander has to know the capabilities of the units, and more importantly the people. In processing data about the enemy, terrain, troops, weather, and political climate from the operating environment, the commander builds an understanding of the events that have recently taken place as he attempts to influence future events. Speed, reliability of information, level of stress, the way in which the information is presented, experience, and cognitive skills all play a factor in his ability to assimilate and compile the information. Staff synchronization and the commander's utilization of their skills also contributes. Incorporating these factors, the commander attempts to visualize what is happening. Visualization is the core mental process that allows a commander to know when, where, and if to make a decision.

Conflicting information or misinterpretation caused by any of the factors being out of step contributes to the fog of war and can have devastating effects as evidenced by military history, which is replete with examples. Overcoming the fog in developing situational awareness might be the true test of the art of command and might be accomplished through:

- Incremental decisions or conclusions until other techniques, such as gathering more information, have resolved the fog
- Contingency plans in place to mitigate assumptions proving invalid, analysis proving faulty, or initial decision incorrect
- Flexibility incorporated into the plan

Commanders make decision based on what they believe is happening and the visual image they develop will determine

what decisions are made. Too much information can be as crippling as too little in one's attempt to develop good "SA." Uncertainty about what is happening can arise from unreliable or untimely information. The fog this creates can be resolved by collecting more information, although time and other resources become a factor with this approach, or through the use of mission-oriented C^2.

C. MISSION-ORIENTED COMMAND

Mission-oriented command relies on the use of mission tactics in which seniors assign missions and explain the underlying intent but leave subordinates as free as possible to choose the manner of accomplishment. (MCDP 6, p. 109) The alternative is a detailed C^2 approach, which almost certainly breeds micro-management and slower decision-making. Figure 8 dissects these approaches and highlights differences.

MISSION	COMMAND	DETAILED
ASSUME WAR IS-- Probabilistic Unpredictable		ASSUME WAR IS-- Deterministic Predictable
ACCEPTS-- Disorder Uncertainty		SEEKS-- Order Certainty
TENDS TO LEAD TO-- Decentralization Spontaneity Informality Loose Rein Self-discipline Initiative Cooperation Acceptable Decision Ability Throughout		TENDS TO LEAD TO-- Centralization Coercion Formality Tight Rein Imposed Discipline Obedience Compliance Optimal Decisions Ability Mostly At Top
COMMUNICATIONS: Implicit Vertical & Horizontal Interactive		COMMUNICATIONS: Explicit Vertical Linear
ORGANIZATION Organic Ad Hoc		ORGANIZATION: Hierarchic Bureaucratic
LEADERSHIP: Delegating Transformational		LEADERSHIP: Directing Transactional
APPROPRIATE TO-- Art Of War Conduct Of Operations		APPROPRIATE TO-- Science Of War Technical/ procedural Tasks

Figure 8. Mission vs Detailed C^2 (from FM 6-0, p. 1-14)

Through a shared vision, focused on the objective, mission-oriented military operations can be achieved using decentralized execution. It directly addresses the issues of uncertainty and time, generated by the fog of war, in a number of ways. It reduces the amount of certainty needed for subordinates to act, as this is guided through the articulated intent, mission type orders, and shared vision. Once engaged, it utilizes implicit communications, keeping orders and plans as brief as possible. These serve to decentralize decision-making, which increases the tempo and improves the force's ability to deal with fluid and disorderly situations. Mission-oriented command and control begins with commander's intent.

1. Commander's Intent

Commander's intent is a mechanism that describes what is important through a common vision, articulated through a concise statement of what the force must do and the conditions the force must meet to succeed. In short, it describes the desired end-state and the general path to get there. It should pull the various separate actions of the force together, establishing and underlying purpose and focus. It should provide the guidelines, constraints, restraints and the logic that allows subordinates to act according to their own unique circumstances while maintaining harmony with one another while keeping focus on the commander's goals and objectives.

Communications must be encouraged among, and with staff, peers, and subordinates. Intentions are only may clear when they are presented in such a way that

subordinates fully understand all relevant points. Although communications can be written or verbal, face-to-face communications are the most effective means because we use more than words to communicate. A quote from an Israeli Commander during the six day war of 1967 adds clarification to this point.

> There is no alternative to looking into a subordinate's eyes, listening to his tone of voice, and observing his behavior when issuing orders. (FM 6-0, p.)

2. Mutual Trust

Mutual trust must exist between all the elements of an organization using mission-oriented C^2. Trust among commanders, staffs, and individuals gives rise to cooperation, coordination, and confidence. Decentralized operations demand trust and mutual understanding because they are critical to tempo. As confidence in the abilities and judgment of subordinates, peers, and seniors increases so does the effectiveness of the process, which serves to free the commander. Trust is something that must be earned as well as given. This is done by developing a sense of responsibility, loyalty, and self-discipline amongst the organizational elements through training like they plan on fighting.

Training of staffs and subordinates is not something that should be an issue after crossing the line of departure. Warfighting skills are perishable and operational units have to be tactically and technically proficient. Systems require operators, but commanders must also be aware of strengths and weaknesses and how best to

leverage the technology. Subordinate commanders, in developing their own situational awareness, need to understand the operations two levels up, and these skills can be honed through a comprehensive training approach. Demonstrated confidence and trust grows as a "team" solidifies through training. Trust also improves morale as individuals begin to identify with the group and its goals. (FM 6-0, p.4-20)

3. Subordinate Initiative

Allowing subordinates to seek out and exploit rapidly fleeting opportunities in pursuit of the mission serves to offset some of the uncertainty faced by the commander. Initiative requires decisions and actions. Subordinates must decide and initiate independent action to overcome unanticipated obstacles or seize targets of opportunity while operating within the scope of the commander's intent. Initiative places special burdens on subordinates, who must always keep the larger situation in mind. It also places burdens on superiors who must delegate responsibility for such actions. Delegating the authority to subordinates does not absolve higher commanders of ultimate responsibility. Relying on subordinate initiative to overcome some of the uncertainty, a commander must trust his subordinates and clearly articulate his intent to those he expects to capitalize on opportunities. This also becomes easier as cohesiveness is formed through training and an operational climate that promotes calculated, disciplined risk-taking, which is much different than gambling.

In assessing subordinates, commanders who adopt a coach and mentor approach when training have the opportunity to study the personality and characteristics of staff and subordinates. Understanding the intellect, common sense, proficiency, and ability to deal with stress of those being evaluated helps the commander gauge capabilities and provides some insight into their initiative and boldness. Capitalizing on strengths and weakness of members of the organization is a tool commanders use to attack problems, formulate decisions, and create a positive C^2 environment. As a result, trust develops and the organization becomes more effective.

Risk associated with decision-making is acceptable when armed with enough information to visualize the outcome in terms of mission accomplishment or damage to one's force. (FM 6-0, p. 2-21) Subordinate initiative builds confidence and pride in individual abilities positively effecting unit morale and overall effectiveness.

Effective command and control is really about the people involved in the process and organization. A unit with inferior technology but abundant determination will always defeat the most technologically superior adversary with little determination. The determination of which we speak is in large part due to the command climate of the unit. It would be easy and accurate to categorize the previous items as a function of leadership and the responsibility of the commander. Many have been touched upon in previous sections and are factors we would consider just good common sense, but they bear repeating because they are crucial in setting the tone in which the people in

the process have to operate. It is the people who make the organization and process effective.

D. INFORMATION MANAGEMENT

Information is the most important component of control as commander's decisions, dissemination of orders, and the monitoring and supervision of activities all require information. Information drives how the commander visualizes what is taking place in the battlespace, but if improperly managed, it may do nothing to assist the decision-maker. It is the management of the information that provides the mechanism to use it to create effective command and control. Information management serves to narrow the gap between the information the commander needs and that, which is available to him. The management of information should facilitate the rapid, distributed, and unconstrained flow of information in all directions to better balance decision-making at all levels.

It should be presented, to the extent possible, in a visual or image based format for ease of comprehension. Decision-makers do not have the luxury of sifting through masses of data to develop the information they need to orient, decide, and act. It should also discriminate as to importance, quality and timeliness as it is intended to enhance the ability of commanders to communicate understanding, concept, and intent with clarity, intensity, and speed. It should also focus on those critical information requirements, which directly affect his decisions. What this requires is a means of aggregating, fusing and prioritizing. Recall the Monday Night Football

analogy. No single person can digest all the information generated with our tech-heavy structure. Training of the people who will be charged with aggregating, fusing, and prioritizing will be a challenge that is discussed further in chapter VII. As we consider organizational changes to meet future challenges by reducing echelons of command, we will still have to interpret, aggregate, and filter information. As incoming information grows, it is not hard to envision adding more people to perform these functions. This would in essence, restore the delays the organizational shifts seek to eliminate, and slow the decision-making process reducing overall effectiveness. An appreciation of the challenges we face with managing information stems from the type of information that will be processed.

1. Categories of Information

Most military organizations categorize the types of information they use as critical, exceptional, or routine. Critical information directly affects the successful execution of the operations. Commander's Critical Information Requirements (CCIRs) include information that has direct bearing on the commander's decisions. These items are specified by the commander for each operation and apply to events or activities that are predictable. CCIRs are time sensitive and can incur no delay when being relayed to the commander, staff and subordinate commanders. Determining the critical information helps the commander reduce the amount of information reported to him to those items that are urgent to mission accomplishment. (FM 6-0, p.I-1) The answers provided by CCIRs might help the

commander determine or validate a course of action by providing previously unknown information.

Exceptional information is specific and immediately vital information that is neither published nor explicitly stated; rather, it must be recognized as vital by tactically and technically competent subordinates and staff. The purpose of this information is to signal the occurrence of one or more unpredictable our extraordinary events, such as an unforeseen opportunity. Exceptional information must be addressed immediately and there can no delays in transmission of it, or decisions required as a result of receiving it. These types of information are applicable to both the friendly and enemy situations. (FM 6-0, p.I-2)

Routine information is categorized by the standard, repetitive type that occurs daily as indicated by SOPs. Reports on personnel and equipment that is used within and between staffs requiring little commander involvement characterize these types of reports. They are used to prepare and verify estimates and help to identify and anticipate potential problem areas. This type of information is not time-sensitive in terms of decision-making and is normally transmitted via predetermined formats and channels.

2. Information Management Activities

Information management consists of five activities: collecting, processing, storing, displaying, and disseminating information. These activities fit within the construct of the C^2 process and overlap in practice.

Collecting information resides within the information gathering process described previously and takes two basic forms: information push and information pull. The information that is required routinely is pushed from the source to the user as it becomes available. This "push" is multi-directional in nature among senior, subordinate, and lateral commands. There are applications, especially in the intelligence community, where this information may be time sensitive, but for the most part it is not. It also alleviates the problem of burdening subordinates from their operations and tasks with excessive requests for information. Information push does not work well in obtaining information to meet unforeseen needs, especially those time-critical requirements.

Information-pull is designed to react to needs for information as the user generates information requirements. The source provides information in response, and this too is should be a multidirectional approach. It is intended to fill information demands quickly and efficiently and often utilizes a common database as a way to serve the needs. Information not immediately available triggers the chain of command until it reaches the appropriate level for collecting data. (FM 6-0, p. 3-12) This approach helps to focus scarce resources on the critical information and exceptional information requirements that develop and only produces the information needed.

The function of information management is spread across the spectrum of the current military organization. Intelligence gathers the data, communications provides the means for transmission, and the commander via operations

determines what information is required. All units, echelons, and functions utilize the information produced, but where this function resides is a question most organizations are working through as we evolve technologically. Information managers have been charged with figuring this out, but few aspire to fill these important billets.

3. Information Manager

Pulling the activities of information management together is the job of the Information Manager (IM). This individual has a precarious job as it requires him to be able to understand requirements at his level, capabilities at levels above, below and adjacent, and understand how to fuse the information into a coherent and understandable format. The information manager monitors the performance and responsibilities of individuals in processing information to support the operations and the flow that feeds the information systems. He is required to collect, task, analyze and present the information in a timely manner.

Although some designate the Executive Officer (XO) or second in command as the information manager, it is rapidly developing into a job that requires some specific skills that the XO may not have by default. In planning, operating, and maintaining a system used to meet information requirements, the IM has to understand what information is needed by and from each functional area to develop the comprehensive look. To accomplish this the IM must not only understand the commander’s intent and his

information requirements, he must be well versed in all the functional areas that he is pulling information from as he builds a common operational picture. This is an extremely challenging job complicated by a seemingly endless infusion of technology. Training of such an individual would take some time and could require organizational changes as well.

Experience is the key to success in a billet of this nature. The person assigned as the IM should have adequate time serving at that operating level to fully appreciate the intricacies and idiosyncrasies of the commander and the organization. The IM must be well-rounded with respect to functional capabilities of the organization and have a solid understanding of the C^2 systems. How to accomplish this is another issue, but suffice it to say, one that we must address as the IM becomes more and more critical to our abilities to filter, aggregate, and disseminate information. It is interesting to note that as we consider networked organizations and streamlined chains of command, we have created a billet, or staff, responsible for managing the very information we say is critical to all commanders in their decision-making.

The job of the information manager will be more than just developing procedures and gathering requirements. It is quickly developing into the executive producer, made reference to previously, who will be required to do many things and make his own decisions on what information to present, information that commanders will use in deciding what actions to take. Savvy, aggressive, and smart are just a few of the attributes this individual will need to possess if he is to contribute to command and control

effectiveness. Perhaps it is time to begin investing in efforts to develop and train the Information Manager.

E. SUMMARY

Building effective command and control is about the people in the process. Soldiers, Sailors, Airmen, and Marines will ultimately make the decisions required in time of war regardless of the technology at their disposal. The commander, the guidelines he sets, and the atmosphere he creates will largely determine how effective the C^2 process will be. Volumes of information will have to be considered, and our abilities to do this also contribute to effectiveness. In striving to become more efficient we should consider people first, technology second, and the creation of a command climate that allows the first to fully utilize the second in pursuit of mission accomplishment.

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VII. COMMAND AND CONTROL CHALLENGES

A. INTRODUCTION

Each aspect of command and control brings unique challenges that exist today. The uniqueness of people in the process and the organizations they work within have contributed, and will continue to contribute, to the challenges faced as we move toward a force designed with flexibility and effectiveness in mind. To create such a force, DoD is planning to rely more than ever before on high technology C^2 systems to leverage military assets as our vision is one of information superiority. It is the current and future reliance on systems that presents the biggest challenge and in large part drives the challenges of the people and the organizations.

C^2 processes are being transformed by the new technologies of the information age. Older systems built for stand-alone or single purposes must be matriculated to meet explicit requirements for interoperability, flexibility, and effectiveness. To accomplish this, DoD has been increasingly capitalizing on information technologies for C^2 systems. (National Academy of Science, p.1) The implications of a continued reliance on technology and the transformations imposed on the process can be understood, but few practitioners really understand the changes taking place. Discussion on the interoperability and integration of systems, the information generated, and the characteristics needed in our systems serves to make the challenges and changes we face clear.

B. INTEROPERABILITY

Joint, flexible, coherent, and effective operations are key components of DoD's vision that is predicated on the concept of information superiority, enabled and supported by a network of C^2 systems. Future U.S. military operations will inevitably involve elements from more than one service and possibly coalition forces. The ability to fuse the capabilities and services of these elements into a effective unified military force will require operational interoperability of the forces involved and technical interoperability of the systems. Achieving interoperability is inherently a distributed, horizontal challenge, which must be addressed in a largely vertical environment. (NAS, Exec Summary, p. 5) Interoperability must be built into the force structure across service and unit boundaries to ensure fast and effective responses.

Operational interoperability goes beyond systems and includes the people and procedures that interact on an end-to-end basis. It is accomplished through the use of standards, training, testing, configuration management, and training. Operational interoperability encompasses the full spectrum of military operations. Technical interoperability is required in today's military to achieve the operational type. Technical interoperability must be considered in a variety of contexts and scopes, even for a single mission. Consider the following example of data requirements:

- Gathered from various sources and compiled into a standardized format

- Exchanged between systems of a single organization
- Exchanged between systems of different services over various architectures
- Aggregated at some higher level command and control system to provide added value (NAS, Interoperability, p.4)

The range of requirements for data flow and exchange even at the lowest level underscores the importance of interoperability in every system and at every echelon. Add to this the integration of commercial technology with proprietary military systems as we embark on a networked force and one quickly understands the importance of the issue.

1. The Importance and Difficulty

Current doctrine and emerging concepts require interoperability, which is difficult to achieve, but critical if we are to enjoy continued success. The development and maintenance of a common operational picture, achievable only through interoperability, provides the leverage to make faster decisions. This ability can change the nature and tempo of the environment providing a major advantage to the forces enabled. A lack of this capability slows the process. Where interoperability is lacking, there is the likelihood that multiple systems are performing the same functions, or that information is being processed or manually entered several times. (NAS, Interoperability, p.4) Human initiative and ingenuity often overcome situations where interoperability is an issue, but it certainly comes with a cost, normally

measured in terms of speed and inefficiency. The more people handling and interpreting the data, the more likely errors are introduced into the process.

Non-traditional operations, multi-national involvement, and the emphasis on rapid force projection, task organized to accomplish that specific mission, mean that there will be less time to address interoperability problems. The increasing size of the area of operations that have and will take place require coordinated employment of weapons and forces. To accomplish this, data is increasingly being exchanged between sensors, shooters, and systems that previously operated in stand-alone mode. It is the ability of one system to use and share the products of another system that we intend. Close air support, suppression of enemy air-defense, and deep-strike attacks are just a few of the examples that may require rapid response between various organizations in large battle spaces. Interoperability is required to meet such operational requirements.

This does not mean that universal interoperability is required as it is neither achievable nor necessary. All information in all systems being seamlessly exchanged is not technically feasible given the rate of change in technology and mission. Administrative systems do not have to exchange all information with weapon systems. Understanding the importance of interoperability, determining how much and what is required, and the appropriate allocation of resources to support desired level of interoperability is paramount.

The difficulty in achieving the desired levels of interoperability can be attributed to any number of challenges. Some of the more common ones are highlighted here. Operational units are concerned with the capabilities that exist today. They plan, train, and execute to best leverage what have and what they know works, which often requires working around problems. Planners approach interoperability as something that must be designed into the system. They view changes in the system as important whereas the operator is more concerned with changes in operational capability. Planners approach doctrine and tactics by what is possible when a force is fully equipped, manned, and running. The operators are driven by actual capabilities provided once a system is fielded. These different views create some tension between immediate and future needs, which can fracture interoperability efforts.

The inability to anticipate all relevant uses of the technology adds to the problem. Many of the most common applications of information technology today were unanticipated when the technology was initially deployed. E-mail, once considered a secondary application, is now of the most used applications. It is difficult to conceptualize how emerging technologies will be used in the future, a difficulty that is multiplied when operating in an uncertain environment. (NAS, Interoperability, p. 9) Not knowing how the technology will impact application development and the C^2 process complicates the challenges of interoperability.

Legacy systems not designed to be easily integrated with current and future systems contribute to the challenge as well. New systems must find a way to integrate these systems or add legacy functionality into future design. Integrating different legacy systems, developed in a stovepipe approach only serving parts of the organization, requires significant investment, and replacing them with more interoperable systems is not a short-term option. The acquisition process is not currently able to keep pace with the advances in technology, resulting in short-term system development lagging behind the technology curve almost immediately. Maybe our C^2 systems should not be built on the latest technologies, but on proven architectures, systems, and infrastructure as the decisions made in our process and environment can endanger lives.

Backward compatibility, the use of Commercial Off The Shelf (COTS) products with proprietary technologies, the inherent inadequacies of such products on issues such as security, the controlling of requirements creep and the need for synchronization of interdependent, but independently developed systems, also contribute to the challenge of interoperability. But it is possible to close the gap on the interoperability challenges if we follow some general principles in our approach to technology and systems that were developed in the study by the National Academy of Sciences on Realizing the Potential of C^4I and are listed below.

- The needs of the operational military commander must be the main driver of interoperability solutions and investments.

- While universal interoperability is neither necessary nor achievable, a high degree of it is needed to provide the flexibility for both anticipated mission needs and unanticipated operational deployments.
- Interoperability must be balanced against other fundamental attributes of C^2 systems, including security, availability, flexibility, survivability, and performance.
- C^2 interoperability requires a unifying framework and a body of definitive implementing guidance.
- When developing architectures, use a small team.
- Decompose the problem of achieving defense-wide interoperability into manageable pieces.
- Assess interoperability on the basis of ongoing training and testing.
- Measure progress toward interoperability goals.
- Build a common defense-wide infrastructure to facilitate interoperability
- Engineer flexibility by:
    - Using COTS products, services, and technology whenever possible.
    - Use standards.
    - Base architectures and system designs on layering and clean interfaces.
    - Make data self-describing to permit future interoperability.

The issue of interoperability and the solutions to overcome the challenges associated with it are inherently distributed throughout DoD. Therefore, in achieving interoperability, it will require responsibility and authority that crosses organizational boundaries; a requirement that implies the need for strong top-down leadership. (NAS, Executive Summary, p. 8)

2. Integration

Although some would argue that integration and interoperability are the same, it is a worthwhile exercise to consider the integration of the technologies into our C^2 process as a contributing factor to the interoperability challenge. Richard Hayes, president of Evidence Based Research, illustrates this point well. He argues that C^2 is an adaptive control system that seeks to influence the operating environment, and it is supported by a variety of information systems. Integration is embedding the information systems into the process. He uses the following illustration to show the C^2 process as it has been understood for several decades.

Figure 9. Traditional C^2 Process (from Hayes, p.2)

This supports our previous discussion in which it was pointed out that information systems, for the most part, are very specialized, developed to support a specific function such as intelligence or logistics. They often served as just an aid to conduct the business of that

function, but were rarely integrated into the processes. This has often made it hard for functional areas to share information and to understand the information available to different elements within the organization. As a result, what often occurs is that each staff section uses their unique system to gather the information they need in support of the commander's requirements. They then, along with the other sections, put that information into some sort of standardized format for the commander's use. This can be in the form of written or verbal report, or as is often the case, powerpoint presentations. The traditional C^2 process is cyclical in nature and the information systems used to support it almost guarantee difficulties arising from disjoint decision cycles and information across time, space, and echelons. (Hayes, p. 2-5)

Today, information systems have grown in size and applicability, and we are starting to see command and control processes being hastened by improvements in the technology. Processing power and bandwidth increases have enabled greater sharing of information across the spectrum. The increased utilization of systems has helped to pull the functions closer, increasing awareness and in many cases reducing uncertainty. But for the most part they remain as tools to facilitate the process and not capabilities embedded in the process. Information systems have penetrated deeply into each of the key functional areas, but their impact on doctrine, organizations, and tactics have been minimal. (Hayes, p. 7) We have started to consider these issues, and it is changes in these areas that will determine the success of initiatives such as network-centric warfare and the global information grid.

The type of integration we seek requires that the information systems become embedded in the C^2 processes. Simultaneous planning across echelons of command, all sharing the same information from the start, is the type of capability we seek in structures of the future. Hayes again provides the visual model of where we are headed.

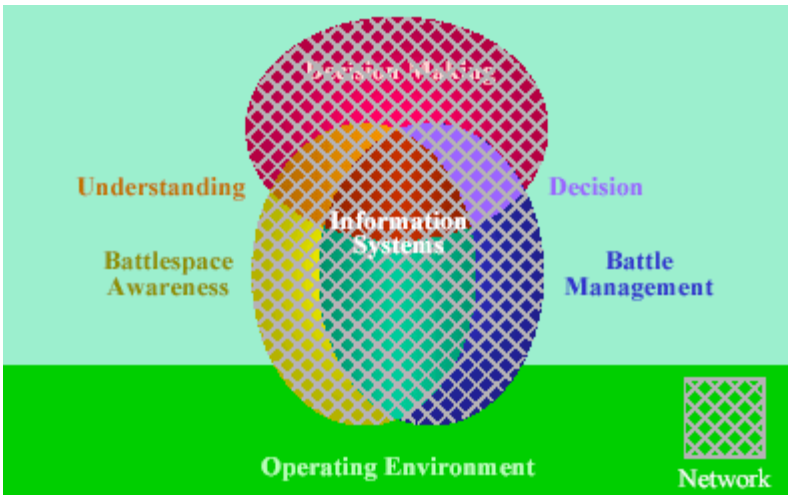

Figure 10. Integrated View (from Hayes, p.8)

The integration we seek in a networked environment will occur over time, space, function, and echelon. It will provide increased information, which should translate to better knowledge, and will be available to more organizations. Some of the challenges associated with such a networked organization have already been discussed, but make no mistake: as we move towards this end-state, it will not be the technology and systems that we find difficult, but the changes in doctrine, organization, and training required to remain effective that will be the real challenge.

C. RELIANCE ON TECHNOLOGY

To this point we have explored the many facets of command and control. Technology has become an essential part of C^2, but it involves more than architectures, systems, and gadgetry. Efforts to improve command and control will fail if we focus exclusively on technical fixes as some people are now, and will continue to be the key to command and control. The most advanced equipment does little good if people do not know how to use it. Commanders must recognize capabilities and limitations, and determine how to work around obstacles created by the technology. We only have to look at some recent U.S. military calamities to see that in may cases our C^2 disasters occurred despite the presence of advanced technology. Pearl Harbor, the Mayaguez incident and events involving the USS Stark and Vincennes demonstrate that state of the art technology was not enough to compensate for fallible human judgment.

1. Avoiding Pitfalls

Heavy reliance on technology to improve the process or solve C^2 problems has associated risks. We have seen that it support every function of the process. It serves to reduce uncertainty by providing more sensors, data, communication channels, and information, but it also increases uncertainty to the extent it’s vulnerable. Losing some of the capabilities provided by the technology can cause chaos as we have become so dependent on them. We must be smart about how we utilize the technology and

suppress the temptation to put "all our eggs in one basket" as pointed out by the former director of national security communications to President Reagan, John Grimes. (Coakley, pp. 73-74)

Having enjoyed considerable technological superiority for an extensive period of time, we must guard against overconfidence. Complete trust in system outputs, precision of instrumentation, and reliability is foolish behavior when we consider how little disturbance or friction it takes to disable or disrupt technology. An adversary who relies on initiative and ingenuity and the 'fog of war' is likely to have more impact on the delicate composition of chip-based weaponry and communication equipment than he ever could on a well-trained, fast-thinking infantryman armed with a reliable carbine.

Given information on how to build a watch when one just wanted to know what time it is, highlights some potential problems brought on by the information age in the form of information overload. Having, the most data is not necessarily a key component of victory, whereas having the right piece of data might be. Finding the critical piece of data, in the mountains of information, to help the decision-maker will be the challenge we face as we steam forward into the information age. This challenge can be reduced through the use of filters and fusion, but these techniques are not without hurdles. The potential for manipulations exist whenever a decision-maker tolerates the intervention of a filter between himself and the raw data, regardless of whether the filtering system is human or machine. (Coakley, p. 79) This can result in

inconsistencies, which otherwise may alert the decision-maker, being dropped or averaged out. Information overload is a problem at all levels. The technology must be incorporated into systems that allow commanders to analyze the data they need without devoting all of their time to this endeavor. Networked organizations and uncertain futures will challenge our abilities to command and control.

Illusions of timely and accurate information were addressed previously, but the fact that commanders depend on information that, to a great extent, has been collected and analyzed electronically, should make us mindful of the need to incorporate other non-digital resources in the formulation of our situational awareness. Vulnerabilities associated with complete reliance on technology such as power disturbances, intended or unintended data corruption, and security issues behoove this approach. This approach also keeps decision-makers from becoming blinded by the technology. There are numerous issues that must be analyzed in the decision-making process. The number of issues increases with each subsequent level of command. The operating environment is full of these variables, all of which cannot be captured by the technology. Commanders must restrain from developing narrowed visions based solely on the digital products they receive, as the other sources of information may be equally important. It is also important to note that no technology or system, developed by humans, is completely flawless. For this reason alone, there should always be an element of uncertainty that we consider as our reliance on automation increases.

2. Recommended Approach

It is human savvy, tenacity, initiative, and ingenuity that have, and will continue, to make the difference on the battlefield. Technology can never replace the flexibility and common sense that can transcend the realm of logic, which only we can contribute. Technology has its vulnerabilities, as do humans, and we must work towards the development of systems that capitalize on the minds ability to explore options and possibilities that would never occur to the computer. Training with the same technology we will use to fight is the mechanism that will facilitate the desired end-state. Variation of training scenarios should be incorporated when possible to point out the support that sophisticated C^2 systems can provide. This applies to system development efforts as well. Imagine the possibilities if units allocated training time for the purpose of supporting system development efforts throughout the entire development process. Current operation tempos may prohibit this, but as we place more and more reliance on technology, this may be a way to ensure that operational requirements are identified and met in systems being developed. An argument could be made that the investment of such an endeavor would pay much larger dividends than current practices. Likewise, we must also train to function independently of high-tech equipment when necessary.

The Secretary of the Navy, Gordon England, pointed out during a speech to the students at NPS that the current training approach works today only because our acquisition

process can not keep pace with technology cycles. That is certainly true, but the training today has unique challenges, that if addressed, will greatly enhance the time to develop a functional force as we introduce new technologies and systems. It appears that the formal schools throughout DoD are disconnected from the development commands. One reason for this is because documentation on systems, whether the use COTS technology or not, usually is the last deliverable item in the contract. Systems are being fielded prior to the training to support the systems entering formal schools. Mobile training teams and contract support attempt to address this shortcoming, but it still leaves a considerable void in capability and utilization. Training commands can go years before conducting reviews, and when they are done, they look to the fleet as the primary input mechanism. Perhaps some closer coordination with the development commands is warranted. Development efforts need input from the schoolhouses from an early start. People educated in the business of training would provide valuable insight to project managers and contractors on their training resources development efforts. A phased timing approach would enhance initial capability when systems are deployed if members of the fleet knew the systems before they were fielded. Integrating the schoolhouses into the development process is called for to improve current development efforts and in preparation for future endeavors.

Technology will continue to influence the way we organize, operate, and fight. It is the humans in the process that will remain the key components in accomplishing the mission. The future calls for an

integrated approach where the best capabilities from both are emphasized and developed with flexibility in mind to meet current and future needs. Full utilization of the technologies being developed and implemented will require some new approaches to training in order to accomplish this.

D. MANAGING CHANGE

Consider our current state within DoD and our visions of the future as outlined in such documents as Joint Vision 2010 and Network-centric Warfare (NCW). Technology-driven transformation is being called for that will require some institutional changes to be successful. Revolutions do not occur smoothly, nor do they succeed without significant breakage on many fronts. They are even more difficult when the institutions are steeped in proud histories and imbued with strong cultures. And, in the absence of an immediate crisis facing them, institutions are particularly challenged to transform themselves. (NAS, Chapter 4, p. 1)

There exist some generally accepted and effective principles for managing change that have been learned from revolutions currently taking place in commercial sectors. Although the military situation is quite different, they can serve as a roadmap when change is required. The first of these is a clear and consistent vision for the future. Senior leaders must set the vision and in doing so must be aware of the capabilities of the technology. They must also provide the resources to test, develop, and train with emerging technology and an acquisition system that does not hamper these efforts.

Change also requires persistent leadership and a sense of urgency. Assignments in the military are relatively short when compared to the time needed to effect major cultural changes. Driving visionaries are needed at the highest levels, and though these individuals exist, they are rarely in the billets long enough to see a major undertaking through to completion. One of the reasons that the natural tendency of the military is to resist change, is because of our short tenures in assignments. Keeping the right people in the right job has proven successful. Admiral Rickover's vision and drive with respect to a nuclear Navy and Rear Admiral Wayne Meyer's oversight of the AEGIS combat system for some 14 years are just two examples.

The willingness and commitment to reengineer any process, doctrine, or organization to achieve desired capabilities is another key to succeeding. In doing so, we must accept some risk as we try to fully exploit the capabilities of the technology needed to get us to the desired state. As previously stated, we must be willing to change the structure to make best use of the technology, vice trying to make the technology fit within a proven, but antiquated structure. The military structure we have used for the last fifty years, despite evolutionary changes in technology, must change if we are to realize our visions.

The visions and technology do not get us headed in the right direction without a willingness to fund the changes and to reprioritize budget allocations. Reprioritization of resources has not taken place. With limited resources, we struggle between allocating dollars for weapons or

information systems. Our incremental approach to budget programming contributes to this challenge as well. This creates some tension between the historical quest of military leadership for traditional weapons modernization and the call for investments in "force multipliers" such as modern C^2 systems. (NRC, p. 186) Capturing the elusive force multiplier is a challenge in and of itself.

E. FORCE MULTIPLICATION

The value of command and control systems is extremely difficult to assess. Certainly they help the commander in "commanding and controlling", usually assisting him in dissemination or communication of a shared image and coping with uncertainty and tempo in conflict. But exactly how much do C^2 systems contribute to success in warfare? (Bjorklund, p. 73). These systems are also intended to improve the quality of decisions made by commanders. As each decision-making process is unique to the human employing it, determining the value of system designed to support the human in this endeavor becomes problematic.

Measures of military effectiveness are a class of information that is used to make decisions about resource allocations and procurements. They are variable of significance associated with the prevailing theory or doctrine of combat. (NAS, p.213) These variables, when evaluating C^2 systems, are much harder to formulate and capture than with weapon systems that are almost entirely evaluated on quantitative data than can be used to do extensive comparative analysis. Measures of effectiveness are tied to doctrinal approaches to operations. C^2 systems

often are geared towards new ways of doing business or new concepts and are difficult to evaluate with existing measures. In the civilian sector, investments in technology are often made on the basis of instinct and judgment rather than analytical data, but in the military, where precious resources are scrutinized by a massive bureaucracy; allocation is granted largely on the measurable improvements they will contribute. Developing measures that allow information systems to compete with weapons systems requires that we first determine what it is that needs to be measured and secondly, the best approach to accomplishing that.

1. What to Measure

There is an emerging industry, comprised mainly of those from the operations research field, that is tackling the issue of what to measure and how to determine effectiveness when evaluating C^2 systems. The National Academy of Science's report on "Realizing the Potential of C^4I" describes some measures that could be used to better understand the impact of C^2 systems on military operation. The first group of measures addresses ongoing performance data that can be readily observed and tracked, such as:

- Number of targets killed per unit time,
- Number of targets killed divided by number of attempts to kill,
- Number of targets put at risk per dollar invested in system capability,
- Percentage of detected security penetrations thwarted per unit time,
- Percentage of enemy attacks deflected,

- Delay in commander's visibility of major battlefield change,
- Decision time-measured as the delay between visibility of information and initiation of action,
- Reaction delay-measured as the time between decision to act and completion of action execution,
- Number of different military units that can be connected to command when needed,
- Time between target identification and weapon-on-target,
- Single-shot probability of kill using a given C4I system/weapon combination, and
- Number of target engagements per unit time.

Observations of aperiodic failures and tallying of root causes makes up the second category and include:

- Mishaps due to friendly fire, and
- Erroneous battlefield descriptions.

Data obtained as a result of simulated tests is the last category identified and includes:

- Time to react to a breach of security, and
- Time to deploy troops in response to a specific threat (NAS, p.214)

These measurements are not all encompassing and have caveats attached. Any measurement of effectiveness can inform, but not substitute for the judgment of senior military leaders. Overreliance on comprehensive quantitative data is likely to delay the changes necessary to exploit the benefits of C^2 technology, because development of such evidence is often time consuming. The measures may help capture the contributions of C^2 systems to

outcomes, but identifying the precise contributions of the systems is hard. Measurement criteria should apply to any systems development effort. When special criteria are used for C^2 systems interpreting the data becomes difficult when comparing it against other metrics, and we run the risk of engineering the metrics to support or defend a particular C^2 system. Command and control systems designed to meet certain needs may have applicability that reaches far beyond the intended need. GPS in an example of an infrastructure technology that weapons systems have come to rely upon. Initial need measurements will not capture the effectiveness when used in a broader scope. The metrics identified above do not really address how the system helps human judgment as they endeavor to make decisions and this remains the crux of the challenge. (NAS, p.215)

2. How to Measure

Once the metrics and measures of military effectiveness are developed, capturing the data presents itself as the next hurdle. More and more stock has been placed in computer modeling and simulations as a way to investigate the worth of new concepts and technologies. They can certainly produce useful information, but it can be less than adequate as the information obtained in a simulation is not particularly vivid or memorable. Data in the form of printouts and static graphics do not have the emotional impact of live demonstrations. The models underlying a simulation are based on an accepted understanding of the problem at hand and the relationship to current doctrine and tactics. Not properly identifying

the problem, which is a challenge in and of itself, leads to poor simulations and evaluations. This approach is not conducive to demonstration of how a radically new doctrine enabled by C^2 technology can lead to dramatically new results. Model fidelity can almost always be challenged because they must make simplifying assumptions about the nature of combat. It is just not possible to capture all the variables in a model. If C4I systems are intended to help decision-making, the models or simulations used must include decision-making. This is extremely difficult to accomplish, as we do not have good models of human decision-making. This leaves the door open to opponents of the development effort. (NAS, p.223)

Live experiments are an alternative approach to explore the use and value of C^2 systems. They have the virtue of greater realism and enable the examination of larger excursions from present doctrine and organization than is possible with simulations. Evaluating human factors working under stressful conditions, and the immediate feedback available to evaluators allows these excursions. Experiments can help uncover integration and interoperability problems and provide valuable training on how to incorporate systems into the processes. Unfortunately, live experiments are expensive to conduct on a large scale, and so they usually only explore small deviations from the accepted wisdom that will not provide the payoff larger deviations would. Small experiments do not provide the insight on the value of C^2 applications that cut across systems, echelons, functions, and services. Small-scale settings are often the only option when conducting experiments due to cost. As a result, small

samples reduce the ability to control variables, and a large number of degrees of freedom make rigorous conclusions a problem. Live experiments attract much public attention, and any failures perceived can quickly lead to loss of support. The incentive to develop tough tests, to fully evaluate a system is lost for fear of dwindling support. (NAS, p.211) Small-scale experiments, that individually take considerable amount of time to plan for and execute, slow the evaluation process. This approach could find the technology being evaluated obsolete before all experiments have been conducted.

Force multiplication metrics based on the C^2 system contributions continue to be researched and developed. The fiscal realities of the military make it difficult to adopt the intuitive approach to systems integration as is often done in the commercial sector. Development of the metrics and the measurement techniques discussed here are only part of the puzzle. Senior leaders and resource oversight members must be educated on the challenges of C^2 system evaluations and consider these when deciding where to best spend the limited dollars.

F. SUMMARY

One may interpret this section as the chicken-little view of command and control. It is not intended to send the message that the 'sky is falling,' but rather to expose the reader to the issues that we cumulatively must consider and address. It is hard to ask the right questions or embark on a plan that allows us to realize future DoD vision if one does not understand the challenges. The

people, information, and structure of the C^2 process share a unique relationship. Changes to any one component have effects on the others and this is why we must invest in understanding how the function of command is implemented by a command and control process and supported by the C^2 systems.

VIII. SUMMARY

Command and control is broadly defined and often misunderstood. Every facet of the military contributes to the process, and the process affects everything associated with the military entity in turn. It is a complicated, yet fascinating topic that requires exploration throughout one's tenure in uniform. Because of its scope, identifying and understanding the fundamentals would seem a logical first step. Although there are endless amounts of information on the subject, few readings or presentations are geared toward an introductory course. The intent of this thesis is to provide such a resource that is geared toward mid-grade officers with some experience at the tactical level in hopes of exposing them to the fundamentals, the issues associated with C^2, and the considerations needed as we continue down the information-age warfare corridor.

The principles of C^2, as defined in current doctrine and by recognized authorities on the subject, provide the underpinnings for defining the command and control process and the components thereof. The people, information, and structure of the process are the central themes discussed throughout the thesis. Organization drives behavior, and an exploration of the current military organization against those needed to achieve DoD's vision of future capabilities highlight the changes required to accomplish this. Decisions about the organization influence the other decisions made by a commander, namely informational and operational. Understanding the relationship between these

types of decisions and how a commander makes them gives the reader some insight as to why decisions are the heart of the C^2 process. Effective command and control is largely a function of the humans in the process. People have, and will continue to, make the difference in warfare. Developing an environment that capitalizes on the strengths of the components while compensating for the weaknesses helps ensure we are effective. The challenges associated with command and control serve as a mechanism to prepare us for the future. These challenges are largely based on the technologies emerging and the considerations required to integrate these into our process as we seek interoperability across the spectrum.

Command and control is not limited to technicians or commanders. It is something that each of us influences and is involved in from the time we enter the military to our last day of service. Recognizing its importance is easily done, but understanding why it is important is the question we should be asking and the focus of this research. It is our ability to build effective command and control that will sustain us in an uncertain future.

APPENDIX A – READINGS

The readings associated with this thesis are on CD-ROM which is held by the C3 academic Group. Copies can be obtained by contacting them.

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APPENDIX B – SLIDES

The slides associated with the research material are on CD-ROM which is held by the C3 academic Group. Copies can be obtained by contacting them.

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